UNITED
NATIONS

E

Economic and Social Council

Distr.
GENERAL

E/C.7/1991/4
19 July 1990

ORIGINAL: ENGLISH

COMMITTEE ON NATURAL RESOURCES
Twelfth session
25 March-4 April 1991
Item 5 of the provisional agenda

MINERAL RESOURCES

Trends and salient issues in the development of mineral resources: a review of recent supply, demand/consumption and price trends

Report of the Secretary-General

SUMMARY

The present report has been prepared in response to Economic and Social Council resolution 1989/5 on trends and salient issues in the development of mineral resources. It reviews such issues as recent consumption and supply and price trends of major, minor and precious metals. It also examines consumption patterns for steel and ferro-alloys. Metal and mineral patterns are reviewed in detail, and the economic implications of production changes are discussed at length. The report addresses new materials and their uses and tries to define their impact on the development of the extractive industry. In addition, recent trends in stocks and prices are illustrated, and metal and mineral markets are forecasted in light of anticipated future metal production and demand. Finally, the report looks into mineral exploration trends and investigates the financing mechanisms which are now available for mining projects. In view of the request expressed in resolution 1989/5, an updated review of recent activities and prospects for small-scale mining in developing countries is also before the Committee (E/C.7/1991/5).

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I. RECENT CONSUMPTION, SUPPLY AND PRICE TRENDS

A. Consumption patterns for industrial base metals

1. The recovery and sustained growth in the consumption of all base metals since the low point of the 1982 recession continued in 1989, but the rate of growth generally declined. Sharp contrasts also emerged between the United States of America, where consumption tended to fall; Western Europe, where growth was sustained; and the Far East, where it was often strong. Taking the non-socialist world as a whole, growth rates for the six major non-ferrous metals displayed mixed fortunes (table 1): primary nickel consumption dropped by an estimated 3.4 per cent; the consumption of slab zinc stagnated; growth in the consumption of tin, lead and aluminium slowed considerably, and copper maintained a steady rate of growth similar to the 1988 level. While the rates of growth of consumption slowed in 1989, the absolute consumption of the major base metals reached post-1982 peaks with the exceptions of nickel and zinc which peaked in 1988. Copper and aluminium consumption achieved all time highs in 1989.

2. Slower world economic growth and high levels of interest rates in the industrial economies were the principal reasons for the slower growth of demand. Base metal consumption fell in several cases in the United States where the high interest rates at the beginning of 1989 and reduced consumer spending had particularly severe consequences for the construction and automotive industries. These effects were less pronounced in most Western European countries, while the major Asian economies continued to grow strongly.

3. In the United States, a major drop in demand for automobiles depressed the offtake of most of the major base metals. Vehicle production fell by 3.4 per cent during 1989, but sales fell by 4 per cent, leading to a rise in vehicle inventories. In January 1990, both Ford and General Motors implemented the temporary closure of more than two thirds of their plants; the result was a 41.6 per cent year-on-year fall in the January production of vehicles to only 592,600 units. It is estimated that United States vehicle production will fall by 2 per cent below 1989 levels in 1990 before increasing by 2.8 per cent in 1991.

4. The effect of declining vehicle production on base metal consumption was exacerbated by the indifferent performance of the construction sector. Industrial building remained fairly buoyant, but residential construction fell due to high mortgage rates and there was a surplus of available office accommodation.

5. Refined copper consumption by the United States fell marginally (table 2). The weak transport and construction sectors adversely effected the offtake of brass mill products, but wire mill order books remained reasonably full as a result of continued strong demand for power and telecommunication cable. Slab zinc and primary aluminium consumption were more severely cut, declining by 2.5 per cent and 3.8 per cent respectively.

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Table 1. Consumption of industrial base metals in non-socialist countries, 1982-1989

(Thousands of tons)

Metal	1982	1983	1984	1985	1986	1987	1988	1989
Primary aluminium	10 818	12 009	12 302	12 540	12 788	13 591	14 460	14 516
Percentage change	-3.4	11.0	2.4	1.9	2.0	6.3	6.4	0.4
Refined copper	6 761	6 843	7 668	7 362	7 709	8 092	8 220	8 369
Percentage change	-6.8	1.2	12.1	-4.0	4.7	5.0	1.6	1.8
Refined lead	3 796	3 805	3 910	4 026	4 117	4 236	4 353	4 428
Percentage change	-2.6	0.2	2.8	3.0	2.3	2.9	2.8	1.7
Primary nickel	456	486	582	569	572	635	672.5	649.5
Percentage change	-4.2	6.6	19.8	-2.2	0.5	11.2	5.9	-3.4
Refined tin	145	149	162	168	173	170	180	183
Percentage change	-8.9	2.8	8.7	3.7	3.0	-1.9	6.0	1.8
Slab zinc	4 250	4 605	4 696	4 745	4 885	5 055	5 244	5 241
Percentage change	-4.2	8.4	2.0	1.0	3.0	3.5	3.7	-0.1

Source: For 1982-1986, World Bureau of Metal Statistics (aluminium, copper, nickel), International Lead and Zinc Study Group (lead, zinc), International Tin Council (tin); for 1986-1989, CRU Metal Monitors and Quarterly Market Service reports.

Table 2. Consumption of industrial base metals, by region, 1987-1989

Metal	Country or region	1987	1988		1989	
		Thousands of tons	Thousands of tons	Percentage change	Thousands of tons	Percentage change
Primary aluminium	United States	4 539	4 598	1.3	4 425	-3.8
	Japan	1 693	2 115	25.9	2 155	1.9
	Western Europe	4 214	4 488	6.5	4 625	3.1
	Other non-socialist	3 145	3 259	3.6	3 311	1.6
	Total, non-socialist	13 591	14 460	6.4	14 516	0.4
Refined copper	United States	2 158	2 178	0.9	2 152	-1.2
	Canada	232	239	3.0	215	-10.0
	Japan	1 285	1 331	3.6	1 443	8.4
	Other Asia	807	862	6.8	927	7.5
	Western Europe	2 803	2 886	3.0	2 919	11.4
	Australasia	125	131	4.8	113	-13.7
	Africa	100	105	5.0	99	-5.7
	Latin America	582	488	-16.2	501	2.7
	Total, non-socialist	8 092	8 220	1.6	8 369	1.8
Refined lead	United States	1 203	1 236	2.7	1 243	0.6
	Canada	103	102	-1.0	95	-6.9
	Japan	378	406	7.4	409	0.7
	Western Europe	1 652	1 701	3.0	1 742	2.4
	Other	900	908	0.9	939	3.4
	Total, non-socialist	4 236	4 353	2.8	4 428	1.7

Table 2 (continued)

Metal	Country or region	1987 Thousands of tons	1988 Thousands of tons	1988 Percentage change	1989 Thousands of tons	1989 Percentage change
Primary nickel	United States	148.3	143.4	-3.3	111.5	-21.0
	Japan	150.0	161.8	7.9	160.5	-0.8
	Western Europe	248.4	273.4	10.1	265.0	-3.1
	Other	88.3	93.9	6.3	95.7	2.0
	Total, non-socialist	635.0	672.5	5.9	649.5	-3.4
Refined tin	United States	37.1	38.5	3.8	38.7	0.5
	Japan	32.6	32.2	-1.2	33.9	5.3
	Western Europe	54.4	60.3	10.8	58.6	-2.8
	Total, industrialized countries	133.8	137.9	3.1	139.2	0.9
	Total, developing countries	35.9	42.0	17.0	43.9	4.5
	Total, non-socialist	169.7	179.9	6.0	183.1	1.8
Slab zinc	United States	1 052	1 089	3.5	1 062	-2.5
	Canada	167	159	-4.8	151	-5.0
	Japan	753	760	0.9	772	1.6
	Western Europe	1 726	1 831	6.1	1 860	1.6
	Others	1 357	1 405	3.5	1 396	-0.6
	Total, non-socialist	5 055	5 244	3.7	5 241	-0.1

Source: Commodities Research Unit metal monitors and quarterly market services, 1989-1990.

6. The Japanese economy continued to expand with GDP rising by 5.0 per cent in 1989, down slightly from 5.9 per cent in 1988. The transport sector performed strongly, with vehicle production in 1989 up by 10.4 per cent on the previous year. Residential construction fell by about 3 per cent but was compensated by a dramatic increase in non-residential building. Primary aluminium and refined copper consumption increased accordingly. Aluminium consumption rose a further 1.9 per cent, after an exceptionally strong 25.9 per cent increase in 1988. Copper consumption grew by 8.4 per cent in 1989. The increase in copper demand was assisted by strong activity in the electrical and mechanical engineering fields. These sectors are expected to grow faster than other industries, therefore increasing the intensity of copper utilization per unit of GDP. Strong metal demand came from other middle-income Asian countries.

7. In Western Europe, the economies of the Federal Republic of Germany, France and Italy performed well, with strong demand for base metals from the transport and construction sectors. The United Kingdom of Great Britain and Northern Ireland fared indifferently under the influence of rising inflation and exceptionally high interest rates which depressed the traditional metal-consuming industries.

8. European production of vehicles rose by approximately 4.5 per cent in 1989. In the Federal Republic of Germany, vehicle production increased by 5 per cent, backed by very strong export demand, which saw 1989 exports increase by 9 per cent. In Italy the construction boom continued, with no sign of slowing. With a strong transport sector and a high demand for power cable, the consumption of refined copper in Italy rose by 4 per cent in 1989. European consumption of primary aluminium increased by 3.1 per cent, while refined copper and slab zinc consumption were 11.4 per cent and 1.6 per cent higher, respectively.

9. In Latin America GDP rose by 0.2 per cent in 1989, in spite of the three major economies - Brazil, Argentina and Mexico - experiencing a contraction in national income. Generally speaking, metal consumption stagnated in the region. Future recovery and growth will depend on the degree of success of monetary and fiscal policies currently being implemented by the various Governments of the region.

10. World lead consumption grew by an estimated 1.7 per cent in 1989. Over 50 per cent of the non-socialist world's lead demand is for automotive batteries. In the United States, refined lead consumption rose by 0.6 per cent, which is, at first sight, surprising, given the drop in vehicle production. Lead consumption for battery replacement, however, is related to vehicle population rather than to production. While original equipment battery demand fell, replacement battery shipments rose by about 0.8 per cent. The demand was assisted by a relatively harsh winter following the hot 1989 summer.

11. The long-term downward trend in the production of lead chemicals continued through 1989. Federal legislation forced some ceramic manufacturers to reduce the amount of lead in their products and it seems likely that continued environmental and health concerns will further limit the use of lead chemicals in the gasoline and pigment markets. On the other hand, the consumption of lead in glass increased with the trend towards larger television sets.

12. European battery production grew strongly in 1989, reflecting higher vehicle populations and increased industrial investment. This was offset to some extent by a fall in the demand for lead pipe, lead sheeting and anti-knock fuel additives. In Japan the consumption of refined lead rose by 0.7 per cent after a substantial increase in demand for lead oxides. Oxide production rose 16 per cent in the first six months, with much of the increase going to the glass industry. Lead consumption in batteries however, stagnated somewhat, partly as a result of the mild 1988/89 winter.

13. 1989 saw a substantial cutback in the world-wide production of stainless steel. The reduction was most dramatic in the United States where stainless output reduced by 12.4 per cent. A slight reduction in final demand was exacerbated by the running down of stocks which had reached high levels. The market embarked on a destocking cycle which appeared to be nearing completion in March 1990. At the same time, austenitic steel production as a proportion of total stainless production fell, due largely to the high price of nickel. The net effect on the United States consumption of primary nickel was a fall of 21 per cent.

14. In Europe stainless steel production fell by 2.4 per cent, with a consequent 3.1 per cent reduction in primary nickel consumption. In Japan, domestic demand for stainless steel remained strong but lower exports resulted in a rise in producers' stocks. The result was a 0.8 per cent reduction in primary nickel consumption. In both regions the proportion of nickel derived from scrap materials as opposed to primary metal, rose strongly in response to the high price of primary metal.

15. In contrast, primary nickel consumption in the other non-Socialist countries increased by 2.0 per cent to an estimated 95,700 tons. This increase was due almost entirely to higher stainless steel capacity and a 24.4 per cent increase in production.

16. United States primary nickel consumption in other end-uses also fell during 1990. Nickel consumption for electroplating was severely reduced by the decline in automobile production while the demand for superalloys for jet engine manufacture appears to have peaked in 1988 and to have fallen steadily throughout 1989. High nickel prices were the primary cause for reduced consumption outside the stainless steel sector in Western Europe and in Japan.

17. The consumption of refined tin grew modestly in 1989. The major use for the metal is in tinplate. In the United States the beverage can market for tinplate has suffered substantially from aluminium substitution, while in Europe and the developing countries, tinplate is still favoured, particularly in view of the cost advantage of steel. Environmental and health concerns have resulted in legislation to remove lead from plumbing solder in many countries. Solders containing 1 per cent copper and 99 per cent tin have replaced 50 per cent lead-50 per cent tin materials.

18. Net exports of aluminium to the Western countries from the centrally planned economies were unusually high, at 314,000 tons in 1988, largely because China (not normally an exporter) sold 151,000 tons to the Western countries. Net exports of

aluminium from the centrally planned economies fell to 260,000 tons in 1989 and are expected to remain at or below that level.

19. Exports of refined copper from the centrally planned economies rose steadily, from 152,000 tons in 1986 to 245,000 tons in 1989, principally as a result of higher Soviet exports. Imports by the centrally planned economies fell slightly in the same period, to 90,000 tons. The centrally planned economies are net importers of copper concentrates, but their purchases have been falling, mainly because China has reduced its intake.

20. The nickel market is strongly influenced by the level of sales from the Soviet Union to the Western countries, originating from the Norilsk mine in Siberia. These increased in 1989, as mentioned below, and are expected to remain strong, although ultimately growing demand for stainless steel within the centrally planned economies should lead to greater nickel consumption, and reduce the export surplus.

21. The centrally planned economies remain, on balance, small importers of refined lead and exporters of slab zinc. However, they are more influential in the concentrate markets for both metals, where they regularly import from the West. The shortfall has been particularly noticeable in the Soviet Union, where the declining quality of lead and zinc ore reserves makes it difficult to sustain production.

22. China is influential also in the markets for tin and some minor metals. Exports of tin from China have declined since 1987, when they were exceptionally high, but even in 1989 they totalled 9,900 tons, and contributed to the weakening of that market at the end of that year and early in 1990.

23. China's exports of antimony and tungsten are much more significant, as a percentage of world supply. In the case of antimony, Chinese mine production has been rising strongly and is equivalent to the total output of the market economy countries. Increased world production depressed the market in 1989 and 1990 to such a point that some major mines were considering closing. The tungsten market has been similarly depressed by increasing supplies, which have outstripped any growth in demand.

B. Consumption patterns for steel and ferro-alloys

24. Crude steel production in the market-economy countries rose by an estimated 1.7 per cent in 1989 (see table 3), but with significant differences between the major regional markets. During 1989, the United States produced at two thirds of capacity.

25. During the first 11 months of 1989, crude steel output in Europe was running between 2 and 3 per cent higher than in 1988. In December however, mills started to cut production in order to reduce inventories. Growth is continuing in the major steel consuming industries, although at a reduced rate. Much demand during the first quarter of 1990 is being met from merchant stocks.

Table 3. Production of steel and consumption of ferro-alloys in market-economy countries, 1982-1989

	1982	1983	1984	1985	1986	1987	1988	1989
Production (millions of tons)								
Steel	398.9	407.3	446.0	451.2	432.5	447.9	472.7	480.6
Percentage change	-13.2	2.1	9.5	1.2	-4.1	3.6	5.5	1.7
Consumption (thousands of tons)								
Ferro-silicon	1 591	1 657	1 881	1 845	1 804	1 903	2 194	2 126
Percentage change	-12.3	4.1	13.5	-1.9	-2.2	5.5	15.3	-3.1
Ferro-manganese	2 172	2 025	2 465	2 243	2 425	2 630	2 941	2 981
Percentage change	-17.5	-6.8	21.7	-9.0	8.1	8.5	11.8	1.4
Silico-manganese	1 116	1 139	1 262	1 315	1 269	1 347	1 439	1 482
Percentage change	-13.3	2.1	10.8	4.2	-3.5	6.1	6.8	3.0

Source: International Iron and Steel Institute; Commodities Research Unit.

26. The Japanese steel industry continued to enjoy a strong economy. The world steel surplus reduced export markets but domestic demand remained sufficiently high to cause supply problems, especially in long products for the construction sector. The Asian steel market as a whole is becoming everyday more competitive, however the increased output, 14 per cent in 1989 will put downward pressure on prices and may adversely effect the profits of the region's steel producers.

27. With no growth in domestic consumption since 1987, the outlook for Latin American producers appears to be grim. Output is expected to rise by about 5 per cent in 1990, which means that the excess will have to be exported into international markets which are already in surplus.

28. The well established trend of crude steel production moving away from the industrialized nations and being taken up by the developing countries is continuing as shown in table 4, although the proportions accounted for by Western Europe and Japan have been stable since 1987. This reflects the stronger competitive position of steel producers in those regions after rationalization and cost-cutting programmes.

Table 4. Location of crude steel production, 1977-1989

(Percentage of total)

	1977	1982	1987	1989
Industrial economies				
Western Europe	35.0	36.2	33.8	34.0
United States	25.6	17.0	18.9	18.4
Japan	23.1	25.0	22.0	22.5
Others	6.5	6.6	5.9	4.5
Total, industrial economies	90.2	84.8	80.6	79.4
Developing countries				
Latin America	4.9	6.7	8.8	8.5
Asia	4.0	7.3	8.9	9.4
Africa, Middle East	0.9	1.2	1.7	2.6
Total, developing countries	9.8	15.2	19.4	20.5

Source: International Iron and Steel Statistics; Commodities Research Unit.

C. Production patterns for non-ferrous metals

29. In the early 1980s, base metal producers underwent a substantial and largely enforced rationalization which resulted above all in improved cost efficiency. In January 1989, British Petroleum followed other major oil companies in withdrawing from the base minerals industry, when it sold its mineral assets to RTZ. This trend has left base metal supply in the hands of traditional operators who, having learned the lessons of the late 1970s, are less inclined to invest in additional capacity on the basis of short-term price booms. The strong metal markets of 1987-1988 therefore, have not spawned a large batch of new mine and smelter projects. The result has been improved stability in the supply of metals.

30. A major, though hopefully transient, threat to this stability at the present time is labour unrest. During the past two years, severe labour disputes have disrupted the supply of metals from Papua New Guinea, Chile, Peru, and Canada, among others.

31. Copper supply has been most seriously affected. The Bougainville copper mine in Papua New Guinea has been closed since May 1989, and it is unlikely that it will be operative during 1990. Production losses to early 1990 are estimated at around 120,000 tons of copper. The Ok Tedi mine supplies 230,000 tons per year of

concentrates to Japan. Since January 1990, the mine has been confronted with several problems which have disrupted production and may affect negatively future operation.

32. In Canada, some 80,000 tons of copper production was lost during 1989, largely as a result of labour-related stoppages at Highland Valley Copper. Normal production was resumed at the end of October after ratification of a new labour contract.

33. Copper production in Zambia has been in decline for many years, as a shortage of foreign exchange has made it difficult to obtain adequate supplies of mining equipment and to maintain transport systems. However, in 1989 Zambian copper production recovered by 5 per cent, to 470,000 tons. In Zaire, on the other hand, which had sustained copper production more successfully during the 1980s, mine production fell by 11 per cent in 1989, to 414,000 tons, and production of blister and anode copper was also below target.

34. Mined copper production increased by some 3 per cent in 1989 to 6.9 m tons (table 5). Total refined production grew at the lower rate of about 2 per cent. The availability of scrap in Europe and North America was tightened by relatively lower metal prices.

35. Primary aluminium production rose by about 3.6 per cent in 1989 despite supply disruptions and falling utilization of smelter capacity in the second half of the year. The fall in the price of primary metal is already threatening to cause production cutbacks. Any likely reductions will be more than offset, however, by about 650,000 tons of new capacity coming onstream in the same period. Two thirds of the new projects are located in Latin America and Asia; they should incur relatively low production costs and hence they are unlikely to be cancelled or delayed. Production cutbacks will occur in the higher-cost producing countries, notably the United States and Western Europe. In Latin America, primary aluminium production will rise from 11.8 per cent of the market economy countries total in 1989 to 13.7 per cent in 1991. This will be largely at the expense of North American and European producers, whose combined share will drop from 65.7 per cent to 63.7 per cent.

36. Refined lead production has increased by an average of 1.1 per cent per annum since 1982, in spite of a similar annual decrease in mined output (see table 5). The growing importance of secondary metal is clearly reflected in these figures. In 1990, however, mine output is set to increase, with large additions coming from the United States and Australia. The full benefit in terms of refined lead production will not be felt in these countries, however, since the bulk of the concentrates will be shipped to Europe and Japan.

Table 5. Metal and mineral production in market-economy countries, 1982-1989

Metal/mineral	Actual								Average annual change (percentage)	Forecast (1990)
	1982	1983	1984	1985	1986	1987	1988	1989		
Aluminium (millions of tons)										
Bauxite	66.5	68.0	80.3	77.3	80.2	84.0	87.5	89.9		..
Percentage change		2.3	18.1	-3.7	3.8	4.7	4.2	2.7	5.0	
Primary aluminium	10.7	11.1	12.7	12.6	12.2	12.9	13.8	14.3		14.3
Percentage change		3.7	14.4	-0.8	-3.2	5.7	7.0	3.6	4.8	
Copper (millions of tons)										
Mine production	6.2	6.3	6.4	6.4	6.4	6.7	6.7	6.9		7.2
Percentage change		1.6	1.6	0.0	0.0	4.7	0.0	3.0	1.6	
Refined production	7.2	7.3	7.2	7.3	7.5	7.7	8.0	8.1		8.5
Percentage change		1.4	-1.4	1.4	2.7	2.7	3.9	1.2	1.8	
Lead (millions of tons)										
Mine production	2.6	2.5	2.4	2.5	2.3	2.4	2.3	2.3		2.5
Percentage change		-3.8	-4.0	4.2	-8.0	4.3	-4.2	0.0	-1.6	
Refined production	4.0	4.0	4.1	4.3	4.1	4.3	4.3	4.3		4.5
Percentage change		0.0	2.5	4.9	-4.7	4.9	0.0	0.0	1.1	
Nickel (thousands of tons)										
Refined production	395.3	442.2	511.8	550.6	530.2	545.8	559.7	569.0		579.4
Percentage change		11.9	15.7	7.6	-3.7	2.9	2.5	1.7	6.3	
Tin (thousands of tons)										
Refined production	192.8	169.6	172.9	169.8	157.0	155.4	177.9	181.4		194.0
Percentage change		-12.0	1.9	-1.8	-7.5	-1.0	14.5	2.0	-0.8	
Zinc (millions of tons)										
Mine production	4.9	4.9	5.1	5.1	5.1	5.4	5.1	5.1		5.4
Percentage change		0.0	4.1	0.0	0.0	5.9	-5.6	0.0	0.6	
Refined production	4.3	4.6	4.9	5.0	4.9	5.1	5.2	5.2		5.3
Percentage change		7.0	6.5	2.0	-2.0	4.1	2.0	0.0	3.0	

Source: World Bureau of Metal Statistics (aluminium, copper, nickel)

International Lead and Zinc Study Group (lead, zinc)

International Tin Council (tin)

Commodities Research Unit metal monitors and quarterly market service reports

1990 Forecast; Commodities Research Unit estimates.

37. Nickel production of the market economy countries rose by 2.2 per cent in 1989 due to higher utilization of capacity, which remained unchanged from 1988. The weak price outlook for this metal suggests that although rated capacity is expected to increase by some 6.9 per cent in 1990, production will not follow suit. Already some of the major producers have announced production cutbacks for 1990. The largest expansion project over the next two years will be the PT Inco project in Indonesia, expected to add about 12,000 tons per year to capacity by late 1990, at low capital and operating costs.

38. During 1989, a record 87,000 tons of nickel was exported to market economy countries economies from CMEA countries. This 24 per cent increase on the previous year was due to a sharp rise in shipments from the Soviet Union.

39. Mine production of tin has increased steadily since 1987. The current low prices are forcing closures amongst the marginal producers in several countries. These closures will be offset by additional low-cost Brazilian production.

40. Zinc mine production dipped in 1988 and 1989 to some 5 per cent less than the 1987 figure of 5.4 m tons of contained metal. This trend will reverse in 1990 when mine production is expected to increase by 5 per cent. The single largest contribution to the increase will come from Cominco's Red Dog mine in Alaska which is scheduled to produce 310,000 tons per year of contained zinc. The temporary closure of the Sullivan mine in January 1990 will reduce mine capacity by 84,000 tons per year. In Australia, the Golden Grove project is due to start up in 1990, which will provide an additional 110,000 tons per year of contained zinc metal.

D. Precious metals and minor metals

41. Table 6 shows the trend in production of precious metals and minor metals since 1984. In some cases, data for the market economy countries production in 1989 is not yet available. The most striking increase has been in the production of gold, which has grown by 7.2 per cent a year since 1984. This growth can be attributed to the price of gold and the high profit margins that were available to new entrants into the gold mining industry in recent years.

42. The gold price peaked in 1980 at over $800/oz and has been in decline since then, though there has been considerable divergence in the rate of decline when measured in the currencies of the major producing countries. Despite this decline, which took the gold price down to below $350/oz at one point during the first half of 1990, the profitability of the industry has until recently been high. Cash production costs the Western producers as a whole averaged $250/oz in 1988 and in 1989, compared with an average gold price of $437/oz and $381/oz in those two years. This incentive to explore for gold, and invest in new mines, has been augmented over most of the past decade by the apparent unattractiveness of exploring for base metal deposits. There has therefore been a heavy concentration of exploration expenditure on gold, and a large number of new deposits have been identified.

Table 6. Production of precious metals and minor metals in the non-socialist world, 1984-1989

	1984	1985	1986	1987	1988	1989
Antimony a/ (thousands of tons)	30.6	31.0	33.7	30.7	28.0	25.5
Bismuth a/ (thousands of tons)	3.3	3.8	3.4	3.5	3.3	..
Chromium b/ (millions of tons)	5.2	5.7	5.9	5.9	6.3	..
Cobalt c/ (thousands of tons)	19.8	21.9	25.9	22.5	21.2	19.7
Gold (tons) a/	1 167.0	1 236.0	1 296.0	1 383.0	1 551.0	1 653.0
Manganese d/ (millions of tons)	11.3	12.3	12.4	11.6	12.1	n.a.
Mercury c/ (thousands of tons)	3.5	3.8	3.3	2.9	3.1	n.a.
Molybdenum a/ (thousands of tons)	83.7	84.6	78.4	71.6	80.1	103.1
Platinum a/ (thousands of oz)	2 470.0	2 530.0	2 540.0	2 700.0	2 820.0	2 825.0
Silver a/ (thousands of tons)	10.0	10.4	10.3	10.9	11.0	10.7
Tungsten a/ (thousands of tons)	21.3	20.9	16.7	11.3	13.67	..
Uranium a/ (thousands of tons)	37.9	35.2	37.8	38.6	37.7	..

Source: Commodities Research Unit metal monitors and quarterly market service reports.

a/ Recoverable content of mine production.

b/ Production of chromite ores.

c/ Production of refined metal.

d/ Gross weight of ore produced.

43. Many of these deposits have been comparatively small and have been amenable to open pit mining, and sometimes to heap leaching. It has been possible therefore to bring them into operation quickly. The major increases in production have been achieved in North America, Brazil, Australia and Papua New Guinea during the period 1984-1989. During the period 1984-1989, United States gold mine production rose from 66 to 259 tons; Canadian production rose from 86 to 158 tons; Australian production, from 39 to 197 tons, Papua New Guinea production, from 19 to 34 tons; and Brazilian production, from 61 to 97 tons. In the case of Brazil, a large proportion of the increase was accounted for by garimpeiros, exploiting rich alluvial or open pit deposits, often at great cost to the surrounding environment. The additional production from Papua New Guinea has come largely from the Ok Tedi mine, where the gold-rich capping of a large copper orebody has been exploited.

44. The rate of increase in Western gold mine production appears likely to slow down in the next 2-3 years, as the weakness in the price deters new investment, and as many of the smaller mines developed in the 1980s come to the end of their short lives, at least as open pit mines. The fundamental influences of supply and demand therefore appear to operate even in the gold market, where for so long the price of the metal had no obvious link with the cost or volume of production.

45. Platinum production has increased by 2.7 per cent a year since 1984, to over 2.8 million ounces in 1989. The motive forces have been price and demand. The price of platinum tracked the gold price very closely from mid 1980 until 1985, but since then it has re-established a substantial premium to the gold price. The prices of other platinum group metals have behaved similarly. Demand for platinum jewellery has continued to grow in Japan, and accounted for about 38 per cent of total Western world demand in 1989. The use of platinum (and also of palladium and rhodium) in auto catalysts continues to grow rapidly. Increasing volumes of platinum are now being used by auto manufacturers in Western Europe, as they start to fit catalysts to new vehicles in advance of the implementation of EEC legislation on the control of noxious exhaust emissions.

46. Supplies of platinum from the USSR to market economy countries more than doubled, from 230,000 to 550,000 oz between 1984 and 1989, reflecting increased production from the huge nickel/platinum mine at Norilsk in Siberia. Secondary supplies from scrapped auto catalysts will become an increasingly important source of supply, but for the immediate future, industrial and jewellery demand seems likely to absorb the growing mined output in the market economy countries.

47. Of the other metals and minerals listed in table 6, some are by-products of major metals. Their output is therefore often determined by the rates of production of major metals, which may be quite unrelated to the demand for the minor by-products. This is the case with cobalt, produced mainly in the copper mines of Zambia and Zaire. Declining cobalt production in both countries reflects shortages of hard currency and spare parts in both countries. Growing demand for cobalt has been satisfied partly through the depletion of large stocks held by the major producer in Zaire. Silver production has been depressed by the weakness of the silver price and by lack of growth in multimetal lead/zinc/silver mines in Peru and Mexico. Weak demand from the nuclear power industry has kept the production of uranium static. Antimony has faced declining prices, under the influence of heavy

supply from China, and a continuing loss of markets for antimony alloys in the battery industry. Production has therefore declined and may fall further.

48. The steel-related minerals, chromium and manganese, have enjoyed much stronger markets in 1989, after several years of over-supply. Production data, when released, will probably show some increase in 1989, although demand for chromium in the special steel industry has fallen again in 1990. Demand for manganese ore strengthened considerably in 1989 and 1990, and prices rose dramatically. Moreover, the improved prices were maintained in annual contracts for 1990, indicating that real tightness in supply had developed after many years in which low prices had discouraged investment in additional mining capacity.

49. Producers of the titanium raw materials, rutile, ilmenite and synthetic rutile, enjoyed good market conditions in 1990. Demand for titanium metal has been boosted by the high rate of production of commercial aircraft and aircraft engines. Demand has also been strong for titanium dioxide, which is used in paint, plastics, paper and ceramics. Consequently, new investment has been stimulated in the production of ilmenite. Two new orebodies will come into production in Western Australia and new projects are well advanced in Madagascar and Sierra Leone.

E. New materials and new uses

50. The development of new materials or of new applications for old materials is necessarily a slow process, as technical standards and requirements must first be defined and then met by the suppliers of materials; much investment in the testing and marketing of new materials for existing products, or of new finished products, is then required before a substantial new demand is created for a metal or mineral. In a period of one or two years, therefore, the continuation of an existing trend can be observed, rather than the gaining of a new market, or the loss of an existing market.

51. The aluminium industry has seen continuing penetration by the aluminium beverage can in the market for beer and carbonated drinks containers, though competition from glass, plastics and tinplate has remained intense. Rates of growth of 3-4 per cent a year up to 1994 are expected in the markets for aluminium in packaging (which includes foil) in Europe and Japan, compared to 2 per cent in the United States, where the aluminium beverage can is already very well established.

52. The growth in the volume of aluminium used in packaging applications is tempered by the continuing efforts of the industry to reduce the thickness of sheet used in making cans, and in the gauge of foil used for food packaging. Canstock gauges in the United States are now down to 0.30 mm and may in the long term be reduced to 0.279 mm. Japan and Europe will follow similar trends. In the foil industry there has been considerable success in the development of composite aluminium/plastic materials for wrapping food, using very fine gauge aluminium foils.

53. The car industry is using increasing volumes of aluminium alloys, particularly for engine parts and for wheels. This is the result of consistent promotion on the part of some major aluminium producers over many years. The appeal of the metal rests not only on its combination of strength and lightness, but also on the relative ease with which it can be recycled, which is an increasingly important factor in societies more and more pre-occupied with environmental issues. Recycling is even more important in the promotion of the aluminium beverage can, since the metal is considerably more expensive than tinplate, its immediate rival, and the use of aluminium can only be justified economically when combined with a recycling system.

54. In the copper industry, the market for long-distance telecommunications cables has now been lost to optic fibre cables, having previously been severely diminished by the introduction of multiplexing, which expanded the carrying capacity of existing copper cables. Copper cables are still preferred in the local network systems and in lines to individual houses and buildings. However, there is a medium-term threat to copper even in these markets, if the cost of installation of optic fibre cables can be reduced. Copper consumption has already suffered some loss of volume through the down-sizing of electrical and electronic strip and of air-conditioning tube. These processes are not likely to be taken further. The tendency is now for the volume increases to work in favour of copper, as greater quantities of copper wiring are used in cars, houses and offices (to serve the growing number of electrical devices now required). In architectural applications, copper sheet continues to grow in popularity, at least in Western Europe.

55. The consumption of nickel and chrome is principally determined by the demand for stainless steel. This has benefited from a strong demand for investment goods (for example, in chemical plants, in the food industry, and in hospitals, dairies, kitchens and any other environment where hygiene is paramount). Stainless steel has also tended to replace carbon steel in car exhaust systems, where durability and resistance to corrosion has become more important, now that they often incorporate expensive catalysts to purify exhaust fumes. These developments are not so much the result of technical breakthroughs but rather of sustained marketing and of the appreciation of the benefits over the lifetime of a product of using a higher quality material. Marketing efforts, supported by the Nickel Development Institute, have also had increasing success in getting stainless steel used in architectural applications, for wall-cladding, hand-rails and other forms of exterior trim.

56. The lead industry has lost markets in petroleum additives, paint, pipes, tubes, cable sheathing, typemetal and solders over the past decade, mainly because of its toxicity. However, its major remaining application, the battery industry, is now gaining markets. Standard starting, lighting and ignition batteries for vehicles are now becoming larger, to cope with the increasing demands imposed by the electrical systems of the modern car.

57. This follows many years when the starting, lighting and ignition battery was steadily reduced in size. Some car manufacturers are even contemplating the installation of two batteries in a car.

58. Applications for traction batteries are also growing, in environments such as airports and warehouses where diesel-powered vehicles are not suitable. The development of a battery-driven passenger car is still some way off, although important progress has been made by some manufacturers in increasing the range, speed and acceleration of prototype electric cars. The lead/acid battery is still the most likely form of propulsion for the electric car of the future, although work has been done on other battery formulations.

59. Applications for stationary batteries are growing, in computer back-up systems and in hand-held power tools particularly. In these and all other battery applications, the ease with which lead/acid batteries can be recycled plays a major part in winning larger markets. A new application which has interesting potential is in asphalt road surfacing, where a small addition of lead can result in much greater durability and less surface cracking. In the construction industry, the growth in the use of lead roofing sheet in parts of Western Europe has probably reached its peak, though there is untapped potential in this market in the United States.

60. Growth in the demand for zinc rests heavily on developing new markets for galvanized steel. Resistance to corrosion is a quality increasingly appreciated in the construction and transportation industries. Lightweight galvanized steel frames are now being used in the housebuilding industry, and zinc coatings are being promoted to provide lasting protection against corrosion on bridges and other heavy steel structures.

61. Galvanized steel sheet (either one-sided or two-sided) is now widely used for motor car bodies. In 1988 it was estimated that the external body sheets of 80 per cent of United States cars were protected with zinc, whereas only 50 per cent of European cars and 30 per cent of Japanese cars had similar zinc protection. There is scope for considerable growth in this application for zinc in the latter two areas, therefore, and additional galvanising capacity is being installed in both areas. The total additional demand for zinc from this end-use could amount to 250,000 tons per year by the year 1994.

62. This market, however, will be affected by competition from plastic sheet, which could ultimately replace steel sheet in car bodies, and, in the immediate future, by the success of alloy coatings, as opposed to pure zinc coatings. Galvalume, which is 55 per cent aluminium and 45 per cent zinc is the major threat to conventional zinc galvanizing, and so far has found acceptance mainly in sheet for roofing and siding. Galfan, a 95 per cent zinc and 5 per cent aluminium/mischmetal alloy, is produced in much smaller quantities than Galvalume but offers several technical advantages over Galvalume and conventional galvanizing. Another trend is towards the use of electro-galvanised sheet, rather than hot-dipped galvanised sheet for applications where surface appearance or deep drawing is important. The coating thickness for electro-galvanized sheet is less than half that for hot-dipped. The volume of zinc used in galvanizing will therefore depend on the acceptance of these rival products in the markets for protection against corrosion.

63. In the platinum industry, the major development in recent years has been the growth of platinum-based catalysts for car exhaust systems. This application has been growing at 10 per cent a year since 1984 and now accounts for 37 per cent of all platinum consumption, net of recycled metal. North America, with a net 570,000 ounces, is the largest consumer of platinum in this end-use, but demand is growing rapidly in Western Europe (currently 375,000 ounces net) and in Japan (30,000 ounces net). Air-quality standards are still rising in all three regions, and strong growth in platinum consumption is expected over the next four years. The Eastern European car industry presents a further market opportunity. However, at some point in the mid 1990s, platinum-based catalysts will have achieved virtually full penetration in Western markets, and the volume of metal recycled will be increasing. This section of the platinum market is then likely to face stagnation or even decline.

F. Stocks and prices

64. The average annual prices of the major base metals are shown in table 7. Recent trends in prices and stocks are illustrated in figures I-VI which generally demonstrate the normal inverse relationship between price and stock levels.

65. Between 1982 and 1987, demand for base metal was met partially by drawing down stocks that had accumulated as a result of over-production around the time of the 1981-1982 recession. Stocks reached minimum acceptable levels in 1987-1988, which triggered higher prices and increased utilization of production capacity. During 1989, production of most metals again exceeded demand, stocks increased and prices eased lower. Lead provides an exception; total stocks fell steadily through 1989 with a corresponding rise in the price.

66. In inflation-adjusted terms, the 1988 prices of copper and zinc were only 59 per cent of the 1974 prices, while the price of lead was only 51 per cent of the 1974 price. In contrast, the 1988 average aluminium price was 27 per cent higher than in 1974 and nickel 49 per cent higher. It is not surprising therefore, that nickel and aluminium were the metals whose prices fell most sharply in 1989. This observation also indicates that copper, zinc and lead producers owe more to cost reduction for their recent high profits than the nickel and aluminium industries, where real price increases contributed more substantially.

67. The volume of international trade in base metals is continuing to increase (table 8). The growth is particularly high in the case of aluminium, reflecting the increasing importance of lower cost producers in the developing countries whose metal is exported to consumers in the industrialized economies. In other words, metal production is gradually moving away from the major areas of consumption.

Table 7. Average annual metal prices, 1982-1989

	Aluminium (cents/lb)	Copper (cents/lb)	Lead (cents/lb)	Nickel ($/lb)	Tin ($/lb)	Zinc (cents/lb)
1982	45.1	67.2	24.7	2.18	5.80	33.8
1983	65.2	72.2	19.2	2.13	5.90	34.8
1984	56.8	62.5	20.1	2.16	5.56	40.4
1985	47.2	64.9	17.6	2.26	5.57	34.9
1986	52.2	62.3	18.5	1.76	2.87	34.1
1987	71.0	80.8	26.7	2.20	3.03	36.2
1988	114.8	118.2	29.8	6.26	3.20	56.2
1989	88.5	129.8	30.7	6.05	3.87	77.7

Source: London Metal Exchange.

FIGURE I. ALUMINIUM: PRICE AND STOCKS, 1988-1990

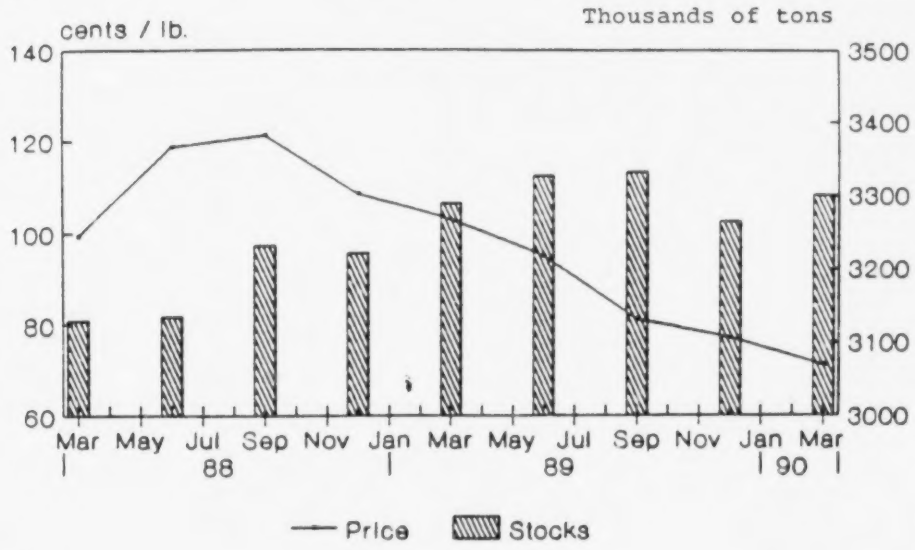

FIGURE II. COPPER: PRICE AND STOCKS, 1988-1990

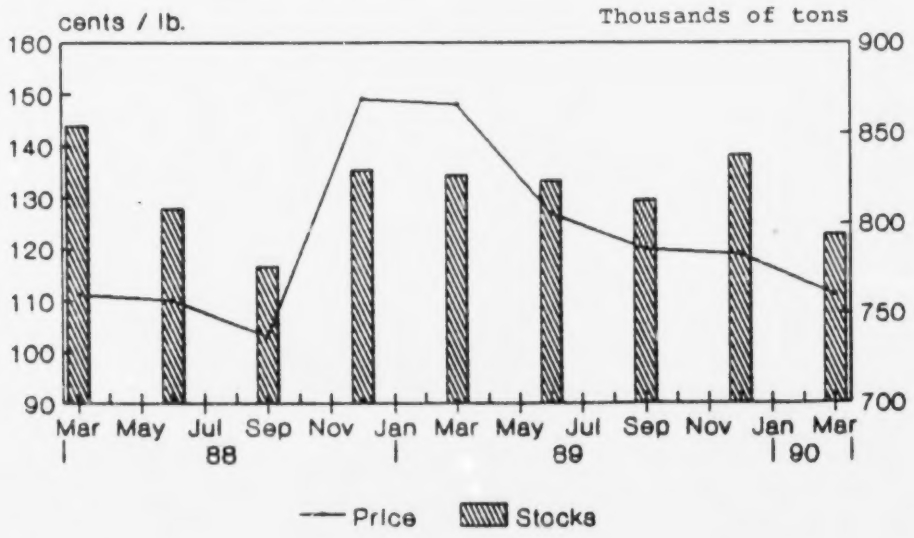

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FIGURE III. LEAD: PRICE AND STOCKS, 1988-1990

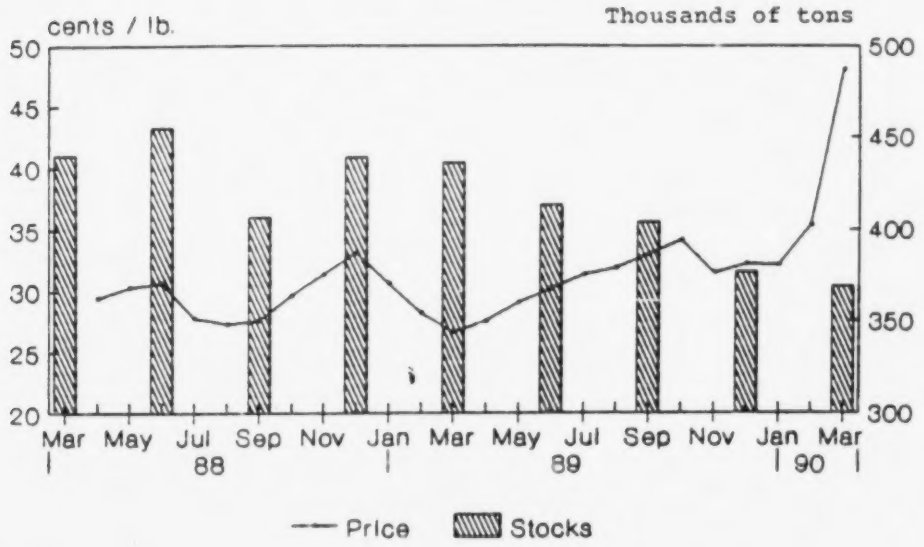

FIGURE IV. NICKEL: PRICE AND STOCKS, 1988-1990

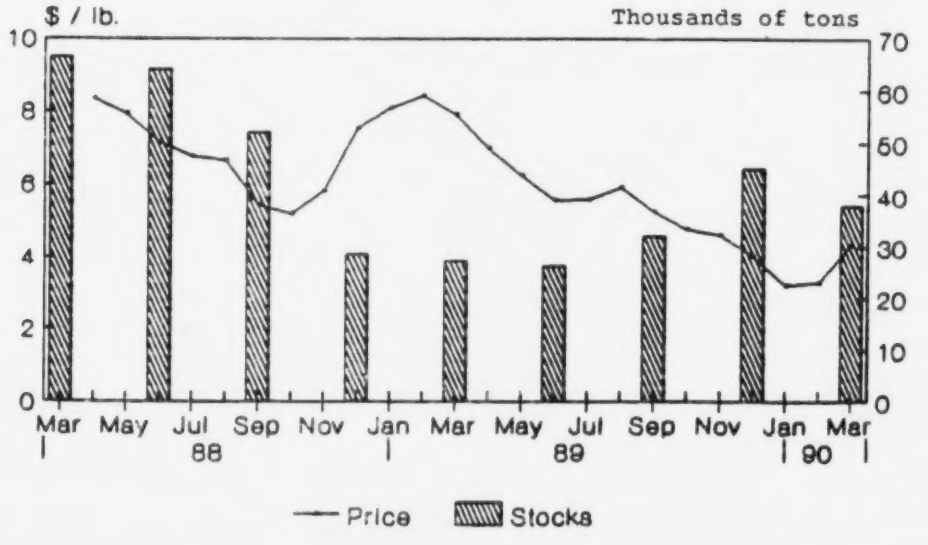

FIGURE V. TIN: PRICE AND STOCKS, 1988-1990

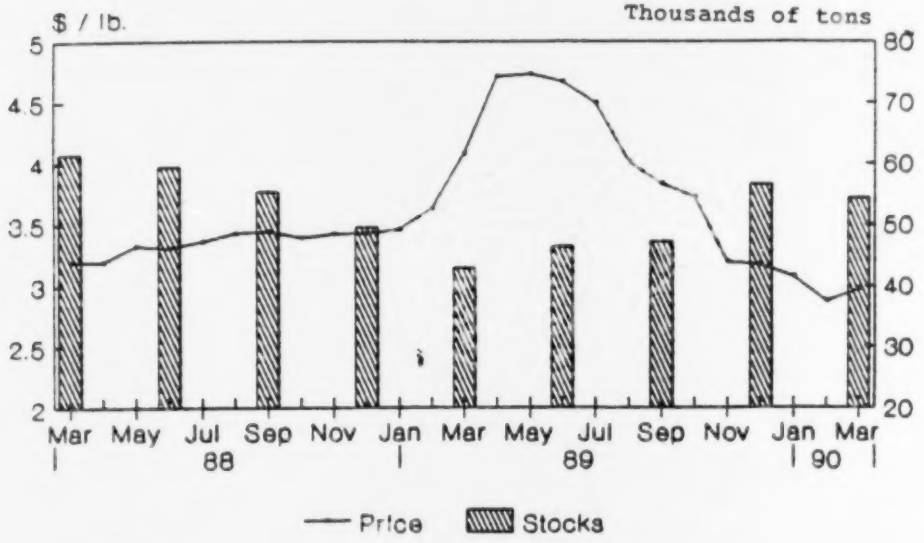

FIGURE VI. ZINC: PRICE AND STOCKS, 1988-1990

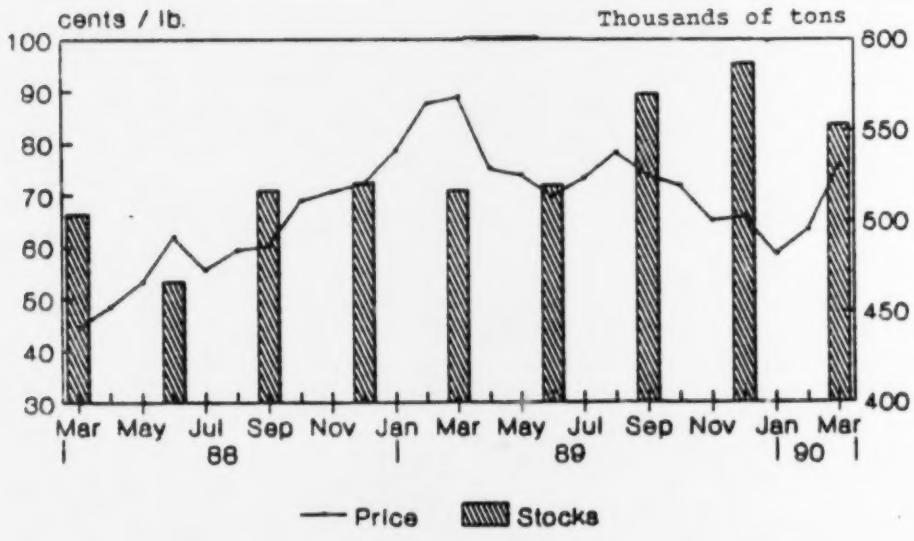

Table 8. Volume of international trade in base metals, 1977-1989

	Average annual growth rate (Thousands of tons)						Trade	
	1977	1980	1983	1986	1988	1989	(percentage)	Consumption
Aluminium	3 396	4 305	5 850	6 459	6 525	7 538	10.16	1.90
Copper	2 926	3 217	2 977	3 156	3 120	3 161	0.66	1.84
Lead	842	783	724	781	766	713	-1.28	0.45
Tin	135	138	114	140	147	133	-1.48	0.13
Zinc	1 460	1 404	1 738	1 784	1 900	1 724	1.51	1.77

Source: World Bureau of Metal Statistics.

Note: Trade is defined as recorded imports of refined metal.

II. PROSPECTS FOR METAL AND MINERAL MARKETS

68. The outlook for metal and mineral producers in mid-1990 is related to a number of factors, some of which are discussed below. Certain production trends for the next two years have already been examined in sub-section C above.

A. Demand outlook

69. The demand for base metals is strongly related to regional and global economic developments. In the first half of 1990, world economic growth was slowing, particularly in the United States and the United Kingdom. This slowdown in growth has been necessary to combat the threat of inflation. Tightening international monetary policy is expected to cause GDP in the Group of 7 countries to ease back to 2.0 per cent in 1990. The year 1990 is expected to provide a low point in the cycle, however, and growth is forecast to accelerate in 1991, backed by a strengthening in residential investment and increased consumer demand.

70. The general outlook for base metal consumption is one of continued slowing of growth in 1990; in the case of nickel, the Western countries consumption is expected to fall due to greatly reduced demand in Europe and Japan. Prospects for 1991 are considerably brighter, however, and demand for all metals is expected to increase in each of the regional markets.

71. Prospects for economic growth, and for the consumption of base metals in the period 1990-1994 are summarized in table 9. Growth in GNP in the major industrialized countries is expected to be slightly higher on average in the period 1990-1994 than in the preceding 15 years, which included two severe recessions. Industrial output, which is more significant to the suppliers of industrial base metals, is expected to grow on average considerably faster than in the preceding period.

72. The forecast rates of growth derived from these industrial production forecasts are in the range of 2-3 per cent for the five major base metals. These figures are generally higher than would have been considered likely within these industries during the 1980s. They owe something to the rapid rates of growth now being achieved by several Asian developing countries, as well as to a continuing period of strong expenditure on investment goods in the major economies. Economic progress in Latin America and Africa is assumed to remain slow.

Table 9. Forecast growth rates in gross national product, industrial production and base metal consumption (Annual average percentage change)

	Real GNP/GDP		Industrial output	
	1975-1989	1990-1994	1975-1989	1990-1994
United States	2.6	2.7	2.4	2.8
Japan	4.2	4.2	3.8	5.1
Federal Republic of Germany	1.7	2.7	1.2	3.6
France	2.0	3.1	1.5	4.0
United Kingdom	1.9	2.2	1.1	2.6
Italy	2.5	2.9	1.5	4.1
	Metal consumption, 1990-1994			
Aluminium	3.0			
Copper	2.8			
Nickel	2.1			
Lead	2.0			
Zinc	2.6			

Source: Commodities Research Unit.

B. Investment strategies

73. The majority of base metal producers have reported substantial profits since 1988, partly as a result of high metal prices but also due to their successful reduction of operating costs which was necessary for their survival in the years following the recession of 1981-1982. How those companies have elected to invest their recent profits is an important indicator of future production trends.

74. The industry's response to peaks in the metal price cycles during the 1970s was to invest heavily in new capacity. This in turn caused the metal markets to move into surplus and exerted severe downward pressure on metal prices. Many higher cost producers then became non-viable as metal prices collapsed, and the profitability of all producers suffered badly. During the 1987-1989 boom however, different trends in investment policy emerged:

(a) A continuing emphasis on cost reduction. A considerable proportion of available capital is still being invested in projects designed to reduce operating costs. This will improve the ability of the companies making such investments to compete in less favourable market conditions;

(b) Low-cost additions to capacity. New projects are being assessed in terms of their competitive position on the industry's cost curves, rather than in relation to recent high metal prices. This has resulted in preference for very large, high-grade mines, on the one hand, and expansion of existing projects, on the other. Both types of project have low operating costs, and expansions also have low capital costs;

(c) High environmental expenditure. An increasing amount of money is being spent on projects designed to reduce damage to the environment. While it increases unit capital and operating costs, this is now viewed as necessary expenditure and in many cases is a legislative requirement. During 1990, for example, Inco will devote 30 per cent of its $500 million capital budget to the reduction of sulphur dioxide emission at its Sudbury smelter in Canada;

(d) The repayment of debt. This is a high priority for many producers, especially those whose borrowings were excessive during the recession;

(e) The repurchase of shares. Several North American producers have implemented share repurchase schemes in order to reduce their equity base and increase the assets and earning attributable to the remaining shares. Inco again provides an example; in the first quarter of 1990, the Canadian nickel producer spent $12 million on the purchase and cancellation of 500,000 common shares;

(f) Downstream or upstream investment or integration. The potential benefits of this strategy include access to more profitable industry sectors, access to raw material supplies and risk spreading through investment in industries with different cycles of prices and profits;

(g) Increased dividends. Shareholders have been rewarded with substantially improved dividend yields after some years of low returns, or no returns at all during the early 1980s;

(h) Mergers and acquisitions. Larger companies have sometimes recently preferred to expand or diversify by acquiring existing companies, rather than by direct investment in new projects. A major example is the acquisition of BP Minerals by RTZ. This policy has resulted in a consolidation of the mining industry.

75. In the developing countries, State-owned companies have been hampered by lack of capital or access to capital markets and have therefore been less active in promoting projects in the last two years.

76. Total mining and smelting capacity for five major base metals for the period 1989-1991 is shown in table 10, together with percentage changes for each year.

Table 10. Recent and forecast changes in mine and smelter capacity in the non-socialist world

(Millions of tons per year and percentage change)

	1989	1990	1991
Aluminium smelting	14.6	14.9	15.3
	(+2.1)	(+1.8)	(+2.5)
Copper mining	8.26	8.47	8.65
	(+7.7)	(+2.5)	(+2.1)
Copper refining	10.39	10.55	10.70
	(+3.1)	(+1.6)	(+1.4)
Lead mining	3.02	3.15	3.20
	(+2.6)	(+4.2)	(+1.6)
Lead smelting	3.02	3.11	3.23
	(+2.0)	(+2.9)	(+3.9)
Zinc mining	6.52	6.79	6.78
	(+4.6)	(+4.1)	(-0.1)
Zinc smelting	5.94	5.97	6.08
	(+1.9)	(+0.5)	(+1.8)
Nickel smelting	596	603	620
(thousands of tons per year)	(-)	(+1.2)	(+2.8)

Source: Commodities Research Unit.

The rates of growth are small, considering that the years 1987-1989 saw a very substantial and sustained rise in metal prices and in profits. Increases in aluminium smelting capacity in 1989-1991 stem almost entirely from expansions of existing smelters. New plants are coming on stream in Canada, France and India, and a large number of new projects are planned in Venezuela and the Middle East. Growth in copper mining capacity is concentrated largely in Chile, with some expansions in the United States. Additional lead and zinc mine capacity is concentrated in the United States and Australia; smelting capacity changes are more widely scattered and include a number of expansions in developing countries.

C. Price outlook

77. With stock levels for most of the base metals significantly above recent lows, metal prices are unlikely to rise significantly in the short-to-medium term. However, substantial price falls are not expected either. The stock consumption ratios (see table 11) are still low and reflect a major change in the working practice of producers and consumers of metals over the past decade. Better inventory control and a reliance by major consumers on a variety of suppliers has enabled the metal-using industries to operate regularly with a much lower level of stocks than was considered necessary in the late 1970s or early 1980s.

78. Since current prices are in excess of operating costs for most producers, the outlook for the profitability of the industry as a whole is quite favourable. On the other hand, the improved cost efficiency of producers and the policy of holding relatively low levels of stocks has increased the potential volatility of metal prices. If demand for a metal were to drop sharply, the price at which production closures would be justified in order to reduce supply is considerably lower than in the past. The downside price risk in the event of a recession is therefore substantial. On the other hand, the consumer policy of operating with low stock levels means that if production falls short of expectations - perhaps as a result of labour disputes, for example - there is an inadequate buffer stock to meet consumer needs. This situation could drive the price to very high levels.

79. Copper, lead and zinc prices are likely to remain reasonably strong for the first three quarters of 1990. This is because stocks are not likely to build up significantly during that period and prices can be affected by labour unrest causing mine disruption. During the last quarter of 1990, however, these markets are expected to be in modest surplus, a condition that will probably persist well into 1991 and exert some downward pressure on prices.

80. The aluminium price dropped steeply during 1989 and in the first quarter of 1990. Prices are expected to remain more or less at current levels throughout 1990, although the expected announcement of production cutbacks could exert a little upward pressure. The outlook for 1991 is more bullish and prices are expected to strengthen as world economic growth starts to accelerate. An average price of at least $1,750/ton is required to cover full capital and operating costs at a typical new smelter. Unless prices at this level can be reasonably foreseen, a shortage of smelting capacity is likely to emerge, through lack of investment, which will in due course lead to a period of very high prices again.

Table 11. Stock/consumption ratio a/ in major base metals, 1988-1990

	1988	1989				1990
	Dec.	Mar.	June	Sept.	Dec.	Mar.
Aluminium	5.9	5.9	5.8	6.0	5.8	5.1
Copper	5.2	5.1	4.8	5.2	5.3	5.1
Nickel	5.4	5.2	5.6	6.7	7.1	7.0
Lead	5.5	5.0	4.9	4.7	4.6	4.1
Zinc	5.1	5.0	5.1	5.8	5.9	5.5

Source: Commodities Research Unit.

a/ The stock/consumption ratio is the total stock of metal at the end of each quarter expressed as a number of weeks of consumption.

81. Stocks of tin will need to fall considerably before there is any prospect of a major price revival. The mine closures that have been forced by the current low metal price could easily be offset by low-cost production from Brazil. While Brazil has agreed to an export quota for 1990, the amount of smuggled tin leaving the country is hard to control.

82. Weak market fundamentals caused the London Metal Exchange cash price for nickel to drop below $3.00 per lb in January 1990. Since then the market has staged a remarkable recovery along with (equally unforseen) demand for stainless steel. The rise in the nickel price was given added momentum by the announcement of production cutbacks by major producers. The reduction in primary nickel output will total 30,000 tons during 1990. The level of nickel exports from the Soviet Union is very difficult to predict and remains a wild card in any forecast. In all probability, nickel prices will remain within the $3.50-$4.10 range through the end of 1991.

D. Developments in CMEA countries

83. Recent developments in Eastern Europe will undoubtedly have an effect on metal markets. At the time of the preparation of this report a number of East/West joint ventures are being negotiated. Metallgesellschaft AG of the Federal Republic of Germany had signed four major deals in Eastern Europe, one of them for the construction of a DM 130 million steel plant in Ozd, Hungary, and another for a total refurbishment of many German Democratic Republic copper smelters and

refineries. Car manufacturing joint ventures were also planned in Hungary, Czechoslovakia and the German Democratic Republic, and several investments in the manufacturing and housing sectors are anticipated. These factors are not expected to have a major influence on metal markets for at least another two years.

84. In 1989, net exports of nickel from countries of the Council for Mutual Economic Assistance (CMEA) reached a record level of 87,000 tons, boosted by a sharp increase in exports from the Soviet Union and a minor increase from Cuba. Soviet nickel exports are likely to fall somewhat in 1990, partly as the result of lower nickel prices. Soviet copper exports are also expected to fall as a new 100,000 tons per year wire rod mill is brought into production in Moscow. This project is a joint venture with Nokia of Finland.

85. In the slightly longer term, metal consumption in the Eastern European economies will increase. Centrally planned economies have a tendency to inefficiently use metal because of the shortcomings of the price mechanism. When a metal is in short supply, priority is given to increasing production or rationing supply rather than to raising prices and in doing so, deterring wastage by the consumer. A major review of the Soviet mineral policy is under way in the USSR. Should resource efficiency be dramatically improved, the consequences for some metal markets could be significant.

E. Exploration trends

86. During the early 1980s when producers were suffering heavy losses as a result of low metal prices and high production costs, exploration budgets, particularly for base metals, were drastically cut. In the past three years however, the position has changed. In 1987 the Canadian mining industry spent a record $Can 1,500 million on mineral exploration. Several surveys have indicated that Canadian, Australian and American companies have accounted in more than two thirds of world exploration activities and that exploration took place principally in developed countries. The majority of developing countries lagged behind in attracting financing for exploration. The World Bank is drawing attention to the fact that sub-Saharan Africa was worse off in 1989 than in the 1960s and as a result of decreasing exploration effort, its mineral reserves are not being replenished. The two most important characteristics of a potential exploration target are geological potential, followed closely by a favourable climate for investment.

87. During the 1990s it is expected that as a result of political and economic change many developing countries will attract exploration investment since it is considered that the best undiscovered mineral deposits are likely to be found in these countries. In order for these countries to fully exploit their resources potential, it will be important to formulate appropriate policies conducive to investment.

III. FINANCE FOR MINING PROJECTS

88. In addition to traditional equity and loan financing, the mining industry has made increasing use of metal loans in the past three years, and is now starting to employ debt-equity swaps. Metal loans have been used principally to finance new or existing gold mines. A necessary prerequisite was the establishment of a highly liquid gold market, on which considerable quantities of gold could be sold for cash or future delivery. This now exists in London, Zurich, New York and Hong Kong. The second requirement was a source of gold that could be borrowed by commercial banks. The central banks provide this source and are willing to lend gold at interest rates very much lower than those required for any other form of loan.

89. Given these two conditions, the operation of a gold loan is, in principle, simple. A commercial bank borrows gold from a central bank or a trading company and lends it to a company developing a gold mine, at an interest rate which may be as low as 2 or 3 per cent. The borrower sells the metal on the spot market and uses the proceeds to fund the development of the project. Over the period of the loan, a proportion of the mine's gold production is used to repay the metal to the lender. The borrower is therefore protected against price risk, passing up any upside potential for the part of the production that is owed to the bank. The bank will limit its risk by requiring that a sufficient share of the balance of production is sold forward at prices that ensure that the mine's operating costs are covered - however, not so much as to cause undue risk of production shortfall. For the producer, the metal loan is essentially a forward sale, which provides cash at a very low rate of interest. It is therefore a particularly attractive option to the borrower at a time when interest rates are high and when the metal price is considered likely to fall. The producer also normally has the option to repay the loan early by re-purchasing gold on the free market, an option which he will exercise if the spot price is low and if his cash flow is sufficiently good. However, the producer must suffer or enjoy the loss or the profit of their decision.

90. The gold loan market started in 1981 with a single metal loan and peaked in 1988 with 86 such transactions, according to the Commodities Research Unit. In 1989 activity was considerably reduced, but nevertheless it is estimated that over 100 tons of gold were sold on world markets as a result of such transactions, while repayments amounted to 50 tons. Net additional supply to the market as a result of gold loans was therefore about 50 tons. This forward selling of gold, to be repaid from future production, has been stated by many analysts as one of the elements depressing the gold market for the past 3-4 years.

91. Metal loans are not available in this form to fund base metal projects, mainly because commercial banks do not have access to stocks of metal that can be borrowed and re-lent at very low rates of interest. The liquidity of base metal markets is also somewhat less than that of gold. However, loans that are repaid from future production can now be arranged. Mexicana de Cobre raised a $210 million loan in 1989 which will be repaid with copper produced from the La Caridad mine. Instead of repaying cash, the copper producer will deliver metal to a trading company, which will sell it for cash; this will in turn be used to repay the loan. The risk of price volatility has been eliminated by the use of a long-term swap, which establishes a fixed price for the copper over the term of the loan. This loan may set a precedent for other transactions in the base metal industries.

92. Debt-equity swaps have developed as a financing vehicle in some of the heavily indebted developing countries, particularly in Latin America. They provide a means whereby an overseas creditor bank can obtain repayment, at a heavy discount, for part of its long-outstanding debt. A company that wishes to make an investment in a developing country purchases existing debt of that country (denominated in hard currency) on the market at a large discount to its nominal value. It presents the debt to the central bank of the debtor country for cancellation in return for local currency at a smaller discount. The local currency can then be used to fund an investment in the developing country. In effect, the investor obtains local currency at a favourable rate of exchange in order to finance a long-term investment. A recent example of such a transaction occurred in Chile, where Midland Bank, of the United Kingdom, acquired an equity stake in the Los Pelambres copper deposit by means of the debt-equity swap.

93. The use of debt-equity swaps as a means of financing Latin American projects is likely to grow. Obviously, such a system can only be applied in countries with substantial foreign debts which they have limited prospect of repaying and have in place a well structured debt and equity programme. It is only a partial solution to the problem of financing new projects since it can be used only to raise the local currency element in the total cost of a project. It is also operational only in countries whose debt stands at a very large discount in the secondary market; such countries may not be the ones that investors in mining projects consider most attractive.

94. The range of financing instruments available to the mining industry has therefore increased, but they do not supersede the fundamental requirement that a new project must have low costs, good reserves and efficient management, as well as policies conducive for investment.

IV. CONCLUSIONS

95. The rates of consumption of steel and the major base metals decreased in 1989 due to the slowing of world economic growth. This trend will persist throughout the first nine months of 1990; in the final quarter, however, an upturn in most of the major economies is expected. The consumption of all major base metals is expected to grow in 1991. Rates of growth in the years up to 1994 are expected to be higher than for the past 15 years.

96. Metal prices have fallen back in 1990, in line with a lower rate of growth in demand, but remain well above the operating costs of most producers. Prices are expected to be fairly stable in 1990, although the reduced costs of producers and the low stock policy of consumers has increased potential price volatility. The drive toward reduced production costs is a continuing one, because producers are aware of the increasingly competitive nature of their industry. One necessary cost increase, though not directly productive, is the rising amount of expenditure on environmental protection.

97. Producers have also adopted a more cautious approach to investment in additional mine and smelter capacity. This should limit, if not prevent, the creation of excess capacity and large accumulations of stocks, and therefore promote longer-term stability in metal supply and in the profitability of metal production. At the same time, exploration activity is increasing, although only in countries having favourable climates for investment. Developments in the CMEA countries and the success of economic recovery programmes in Latin America could lead to the discovery and development of major ore deposits in these countries.

UNITED
NATIONS

E

Economic and Social Council

Distr.
GENERAL

E/C.7/1991/5
24 July 1990

ORIGINAL: ENGLISH

COMMITTEE ON NATURAL RESOURCES
Twelfth session
25 March-4 April 1991
Item 5 of the provisional agenda

MINERAL RESOURCES

Small-scale mining prospects in developing countries: a review of recent activities

Report of the Secretary-General

SUMMARY

The present report has been prepared in response to Economic and Social Council resolution 1989/5 on developments and issues related to small-scale mining in developing countries. It presents a review of recent activities in the field, including instructive case studies, and discusses selected policy options available on the national, regional and international level to promote this segment of the extractive industry.

If conducted in a systematic and controlled manner, small-scale mining both semi-mechanized and artisanal can make a significant contribution to the national, economic and social objectives in developing countries through the systematic mining of numerous small deposits which would otherwise remain unutilized. This activity provides employment for a large number of low-skilled, frequently rural labour, with moderate requirements in terms of lead time and capital investment.

Regularization of activities in artisanal micro-scale mining through the creation of formal organizational structures, contributes to minimize and avoid unnecessary environment decredation as a result of this activity. The establishment of an enabling economic environment, the provision of financing and the introduction of realistic marketing mechanisms have a powerful promotional effect.

Appropriate technical and managerial assistance is an essential area in which international agencies can continue to promote effectively the process of improving performance and stimulating growth of small-scale mining in developing countries while protecting the natural environment and improving the social standard of workers.

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INTRODUCTION

1. Almost two decades ago, the United Nations took the initiative of drawing international attention for the first time to small-scale mining, then a largely neglected segment of the mineral industry. In 1972, a time when economies of scale were considered the principal determinant of mine size and the trend towards increasing capacities was at its peak, the United Nations published a comprehensive subsectoral review, entitled Small-scale Mining in the Developing Countries. 1/ The report stimulated extensive discussion and awareness at the international level. It also provided much background material for further discussion in later years.

2. In 1978 the first international conference on small-scale mining, sponsored by the United Nations Institute for Training and Research (UNITAR), took place in Jurica, Mexico. Since then, a number of national and international conferences have been held on the subject, and an extensive volume of literature has been published.

3. The depressed state of large parts of the world mining industry during most of the past decade has focused attention on the small-scale segment of the extractive sector. After a painful phase of restructuring, the industry has largely recovered, but interest in small-scale mining persists. Ongoing experiences and achievements have shown the potential benefits of such activity and have sustained the attention in it.

4. The present report has been prepared in response to Economic and Social Council resolution 1989/5. It should be considered in conjunction with other reports on mineral resources submitted to the Committee on Natural Resources at its twelfth session.

5. A previous report, submitted to the Committee in response to Economic and Social Council resolutions 1985/47 and 1987/8, dealt with the motives and scope of the recent interest in small-scale mining, reviewed definition practices proposed, and assessed the significance of the subsector (E/C.7/1989/4 and Add.1). It discussed the characteristics of small-scale mining, relevant national policies, technical co-operation activities of the Department of Technical Co-operation for Development, United Nations Secretariat, and possible future activities.

6. While that report concluded that efforts related to subsector promotion must be made primarily at the national level, it also stressed the need for regional and international co-operation with organizations such as the United Nations and other internationally active funding and technical assistance agencies, and among developing countries.

7. Chapter I below reviews recent activities in small-scale mining. After a general assessment of the importance of small-scale mining, chapter II examines various national policies related to environmental, social, technical, organizational and financial aspects. International policies pertaining to marketing, technical assistance, transfer of technology and international agencies

are addressed in chapter III, while chapter IV discusses human resource development, training and technical co-operation. Chapter V presents relevant results of the Fifth Tripartite Technical Meeting for Mines, other than Coal Mines, convened recently by the International Labour Organisation. Finally, conclusions are offered in chapter VI, and some items for discussion are suggested.

8. In spite of the substantial volume of literature published on small-scale mining in recent years, reporting on the subject is aggravated by a conspicuous lack of accurate and reliable statistical material associated with the limited comparability of data. The informal position of a large portion of the subsector, primarily of the very small artisanal producers, and the absence of a universally accepted and uniformly applied quantitative definition of small-scale mining, are the principal explanations for this situation. Microscale mining in the current context refers to the extraction of usually precious or high-value minerals (gold, gemstones, tin) carried out by individuals frequently as an intermittent activity, primarily from alluvial mineralizations, using handtools and employing essentially traditional manual techniques. As such, it represents the low end of the small-scale mining range. On the other hand, small-scale mining encompasses non-mechanized to mechanized regular extractive operations conducted on a small-scale - e.g., 100,000 tons per year in the case of open pits and 50,000 tons per year with underground mines, depending upon the convention adopted. No accurate quantitative demarcation line exists between the two size categories. A continued determined effort to collect and exchange information, as suggested in the previous report, will help to resolve this information dilemma.

I. RECENT ACTIVITIES IN SMALL-SCALE MINING

9. In September 1988 in Ankara, the Interregional Seminar on Small-scale Mining in Developing Countries was convened by the Department of Technical Co-operation for Development, United Nations Secretariat, in conjunction with local executing agencies. Papers presented and statements delivered by more than 50 participants from developing countries clearly confirmed the high level of small-scale mining activities in a number of countries, including Bolivia, Brazil, Chile, Colombia, Ethiopia, Ghana, India, Indonesia, Kenya, Mexico, Morocco, Papua New Guinea, Peru, Zaire, Zambia and Zimbabwe, and the firm interest to promote growth of the subsector.

10. Another recent event of significance was the establishment in 1989 of an international agency for small-scale mining, Small Mining International (SMI), at the Ecole polytechnique in Montreal, Canada. SMI is a non-profit organization specifically dedicated to strengthening and supporting the small mining sector as an aide to rural social and economic development, particularly in developing countries. While initially the agency's focus will be on information services, co-ordination and linkage among national and international organizations, in the long term it expects to provide other support services, including research, training and the periodic publication of the results of technical meetings and research projects.

11. Also in 1989, in India, one of the leading small-scale mining countries, the National Institute of Small Mines was created to promote the role of small-scale mining in national development and international co-operation. The principal objectives of the organization are to encourage the small mining sect to use technical and scientific methods in its operations, and to raise consciousness regarding environmental protection.

12. In Zimbabwe, another developing country with an impressive small-scale mining record, the Small-scale Miners Association has existed since 1982. As a non-governmental organization of operating and prospective small miners, its main goals are to function as an information and advisory centre and to provide technical and business management training to improve the performance of its members.

13. Zimbabwe is a country with a long tradition in small-scale mining. Chromite mining in the Great Dyke district dates back to the turn of the century. The chromite mining industry today is controlled by Zimbabwe Alloys Ltd., a subsidiary company of Anglo American Corporation and Zimasco, a subsidiary of Union Carbide. In 1983-1984, when the chromite industry went through a particularly difficult period, these companies abandoned a number of less profitable smaller operations, concentrating activities on the larger mines.

14. Faced by unemployment, mine workers, with the support of the Government began to establish chromite mining co-operatives, and continued mining operations. Since then 28 chromite co-operatives - 22 on the North Dyke - with an active labour force of 2,100 persons have been established. The formation of the mining co-operatives was facilitated by the Zimbabwe Mining Development Corporation Act of 1982. The Act states that it shall be one of the duties of the national mining parastatal, the Zimbabwe Mining Development Corporation (ZMDC), to encourage and undertake the formation of mining co-operatives. For the execution of these duties, a Mining Co-operatives Development Department was created within ZMDC.

15. The co-operatives receive extensive technical and administrative assistance by the Government through ZMDC. Services provided primarily include assistance in negotiating ore prices with Zimbabwe Alloys Ltd. and Zimasco, providing geological support in prospecting, attaching resident advisors to each group of four co-operatives, giving administrative and technical training to the management committees and assisting in the acquisition of equipment. A small fee amounting to about 3 per cent of sales revenue is charged by ZMDC for these services.

16. Both Zimbabwe Alloys Ltd. and Zimasco purchase guaranteed minimum tonnages of chromite from the co-operatives. The ore is collected by the companies at the mining sites on the North Dyke and delivered to the refineries situated at Gweru and Kwekwe. The two companies also provide assistance in the form of assaying services free of charge, credit purchases of mining inputs and rental of spare mining equipment.

17. For demonstration purposes, the Ministry of Mines in 1985 also set up a model underground chromite mining co-operative under the direction of a governmental mining engineer with an initial capital of 15,000 Zimbabwe dollars and a voluntary membership of 10. The co-operative produces some 200 tons of chromite per month.

18. Small-scale chromite mining in the North Dyke, however, is not without problems. The small thickness of the chromite veins mined presents a severe barrier to any significant improvement of productivity. Lack of mining equipment frequently poses an additional constraint. Apart from these operational difficulties, the introduction of the system of co-operatives to the chromite mining of Zimbabwe can be considered a success. Experience gained in the process can be valuable for other small-scale mining districts in developing countries.

19. In Bolivia, between 1985 and 1986, in an effort to streamline its operations, the State-owned mining company COMIBOL laid off more than 28,000 workers. Most of them have joined mining co-operatives whose total work force is now estimated at 40,000. Co-operatives are legally working on former COMIBOL tin and base-metal mines abandoned because they were considered economically unattractive. In addition to tin, six minerals are also recovered: gold, silver, zinc, antimony, lead and tungsten. In 1989, the co-operative production contributed 37.3 per cent of the total foreign earnings and 18.8 per cent of Bolivia's total exports. They produced 9,567,071 kg of tin, more than twice as much as COMIBOL. In spite of the fact that the mining artisans use rudimentary tools and methods and get little or no technical support from COMIBOL, their production was 57 per cent greater than in 1988. By contrast, the Mining Bank, Banco Minero, provides credit lines to the microscale gold miners.

20. An instructive case of recent activities concerning small-scale mining can also be reported from Ghana. That West African country has been mining alluvial gold for many centuries and diamonds for several decades. Traditionally, a large rural labour force has been engaged in working the deposits individually on a very small scale, using artisanal methods. Few of the artisanal operations have been officially licensed.

21. An overvalued currency and restrictive legislation have in the past contributed to driving most of these activities into illegality. As a result, the majority of the precious minerals produced by the artisanal segment left the country illegally. According to official estimates, between $15 million and $30 million worth of gold and diamonds were smuggled out Ghana in 1985 alone. Other sources estimate that the values were considerably higher.

22. Against this background, one of the objectives of the Minerals Commission, established by the Government in 1984, was to create an appropriate institutional framework for the artisanal/small-scale mining segment. A process of legalizing the artisanal mining activities was initiated in 1989, with support from the World Bank. In the initial stage, district centres were established by the authorities in eight artisanal gold mining areas, responsible for registration, licensing, training and monitoring. Mine wardens appointed by the Mines Department advise miners in the use of more efficient mining methods. In addition, regular training programmes are offered to the artisanal miners.

23. As part of a purchasing system designed to eliminate illegal trading, buying stations are to be installed in all districts. Field purchases of gold will be conducted by buying agents licensed by the Precious Minerals Marketing Corporation. The pricing arrangement envisaged allows payment of at least

90 per cent of the world market price, based on the market exchange rate instead of the official rate.

24. Buying agents also provide miners with essential operating supplies, such as sluice boxes, pumps and mercury. The regularization campaign of the Government has been a complete success. The gold mining activities of more than 11,000 artisanal workers have been legalized in less than one year.

II. NATIONAL POLICIES

A. Importance of small-scale mining and the contribution of small-scale mines to mineral production

25. Conducted as a systematic and disciplined economic activity, small-scale mining has the potential to make a significant contribution to national objectives in developing countries in various ways. As opposed to large industrial operations, small firms have consistently been identified as a vehicle for the creation of an indigenous entrepreneurship which is a vital force in the process of industrial development. Lower barriers to entry in terms of time, capital and formal training requirements are the principal reasons for this favourable characteristic of small enterprises.

26. While modern mining is a highly capital-intensive business, the financial requirements of small operations are usually only a fraction of those of larger units. This is not only due to the lower capacity levels but also to the fact that small mines, being inherently labour-intensive, generally use mining techniques with a lower degree of mechanization. Thus, in small-scale mining, investment costs per job created are typically only 10-20 per cent of those costs in large, fully mechanized operations, an attribute of particular relevance in economies in which capital is a scarce factor of production, as in many developing countries.

27. Similarly, small mines can be brought into production in a fraction of the time required for large operations. While the latter may need a time span of 5-10 years from the identification of the deposit to full production, small units will usually be operational in a period of from one to two years. Short development periods result in reduced amortization time, rapid return of the capital invested and the early accumulation of new funds for mine expansion or the implementation of additional projects.

28. Small-scale mining and prospecting conducted by small miners or local individuals have traditionally been an important factor in mineral industry development. It has been estimated that in the United States, one of the leading mining countries in the world, more than half of all major mining properties active at the beginning of the past decade derived from exploration targets identified by small prospectors.

29. In addition, small miners frequently play an important role as scavengers, extracting mineralizations too small in tonnage to be mined on a larger scale (Carman, 1987). These mineral resources would remain unutilized in the absence of

a small mining segment. Indications are that, world wide, the number of such mineralizations exceeds the number of deposits mineable on a large scale by several magnitudes.

30. Small-scale mining can, moreover, induce favourable indirect effects in the form of linkages with the secondary and tertiary sectors of the economy. This has been confirmed by the multiplier effects determined in a number of states with significant small mining activities in the United States. Typical values obtained for income multipliers related to small-scale mining and mineral processing amounted to 2-3.5; those for employment multipliers were in the range of 3-5, while output multipliers were found to lie between 1.3 and 2.

31. In view of its typical labour intensity, small-scale mining can have an important impact on the employment situation, particularly in economies with widespread unemployment or underemployment. Labour intensity is greatest in the artisanal operations of microscale mining, diminishing with growing mine size due to the effects of economy of scale and an increasing degree of mechanization. In the two developing countries with probably the largest small-scale mining subsector, Brazil and India, the number of persons engaged in this activity is estimated to exceed 1,000,000 and 500,000, respectively. Employment effects are addressed in more detail in chapter V.

32. Small mines, finally, provide excellent opportunities for the transformation of unskilled labour into semi-skilled and skilled labour. Being essentially labour-intensive, their contribution to the process of basic skill formation can be comparatively greater than that of larger operations.

33. Statistics on the direct contribution of small mines to global, regional and even national mineral production are scarce and of limited reliability. The most comprehensive quantitative assessment of small-scale mining conducted on a global scale was published in 1985, reporting production estimates for 1982 (Carman, 1985). The investigation, which covered the size category below 100,000 tons per year run-of-mine ore production, concluded that the contribution of this segment to the global output of all major metals and industrial minerals in that year amounted to 16 per cent in terms of gross value.

34. The analysis was based on an estimate of the proportion of small-scale mining of individual mineral commodities which rank most importantly in world mineral production statistics. It documented that with a number of significant commodities the share of global output produced by small-scale mining is highly impressive. With fluorspar, graphite, talc, vermiculite and pumice, this share is estimated to be 90 per cent; with feldspar, 80 per cent; clays, 75 per cent; gypsum, 70 per cent; barite, 60 per cent; and sand and gravel, 30 per cent. In metal mining the respective share values are: beryllium, 100 per cent; mercury, 90 per cent; tungsten, 80 per cent; chromite, 50 per cent; and antimony, 45 per cent.

35. On the basis of this detailed investigation and various other relevant sources of information, the contribution of the small-scale mining segment below 100,000 tons annual run-of-mine production for the principal commodity categories can be summarized as follows:

Commodity category	Share in global production (Percentage)
Metals	12
Non-metallic minerals	31
Coal	20
Precious minerals	
Gold	10
Diamonds	10
Gemstones	75

36. In view of the erratic and substantial price movements of many commodities, particularly within the metals category, presentation of data in terms of production volumes appears to be more meaningful and durable than presentation in terms of monetary values. While the data presented indicate that on a global scale the contribution of the small-scale segment to the production of metals is modest, they also confirm that it is quite impressive with non-metallics and gemstones. Given the continued interest in this activity, its share in world mining is likely to grow further.

B. Environmental issues and social services

37. Mining, particularly surface mining, has come to be viewed as an environmentally destructive industry. Environmental effects caused by mining usually take the form of disturbing the land surface, generating noise, vibrations and hazardous waste, and polluting air and water. As a result, extensive legislation regulating mining activities in order to eliminate these effects and largely restore the original situation after mine closure, has become effective in many countries in recent decades.

38. It is apparent that the magnitude of the environmental impact of mineral extraction is related to the size of the operations and the extent and complexity of mineral processing required. Large open cast and underground metal mining operations, with their extensive associated surface facilities, are potential threats to the environment.

39. In the same fashion, extensive uncontrolled artisanal mining activities can cause severe environmental damage, primarily in the form of land degradation resulting from numerous excavations and waste rock piles. This is due to the widespread lack of environmental concern among small operators, combined with the administrative constraints associated with the implementation of environmental controls in view of the large number of operators involved and their frequently dispersed locations. In the microscale mining districts in which numerous artisanal miners operate more or less legally and regularly, the introduction and maintenance of basic environmental standards may prove particularly difficult. In Brazil, the number of garimpeiros, native prospectors digging for gold and cassiterite, mainly in the rain forest of the Amazon Basin, reportedly increased from some 100,000 in 1970 to an estimated 1,000,000 in 1990. The water pollution resulting from the liberal use of mercury is expected to be very serious.

40. While the preservation of a sound environment for future generations is a public responsibility of high priority, not to be disputed, the enforcement of stringent environmental laws has had an adverse effect on mine production costs for most operations, both large and small. Operators will, therefore, adhere to relevant regulations only if forced to do so. Reliable prevention of undesirable effects on the environment by mining requires the preparation of relevant environmental impact statements, associated pre-production environmental management plans and frequently the use of sophisticated equipment.

41. Individual small-scale miners will generally be unable to prepare such plans or afford having them prepared by specialists or to acquire and operate sophisticated pollution-preventing equipment. Implementation of the necessary basic environmental standards in microscale mining districts will, therefore, require a combined approach of external assistance and control, designed to address larger entities instead of individual miners.

42. First, it will in most cases be inevitable that adequate pre-production environmental management plans for micro- and small-scale mining are developed by the regional or national authorities or promotional agencies related to the subsector. Secondly, it will be necessary to enhance awareness among small operators regarding their responsibility towards the natural environment.

43. Thirdly, in artisanal/microscale mining districts, the creation of legalized organizational entities in the form of co-operatives, small operator associations or small mining enterprises will be a pre-condition for a successful environmental programme. Attempts to enforce environmental legislation in artisanal-scale mining without following a course along these lines may force even larger parts of this activity into illegality.

44. Moreover, in metal mining districts in which the operation of processing plants is required in order to obtain a marketable product, the installation of pollution preventing equipment and associated facilities, such as tailings ponds, will frequently become a necessity. In such cases, concentrating mineral processing activities in a single or a few locations by using regional beneficiation plants appears to be the best option.

45. In addition, special attention has to be given to the establishment of appropriate financial instruments for the accumulation of funds required for the reclamation of mined out areas in small-scale mining districts. Small-scale mining legislation currently discussed in the Philippines (Peoples Mining Act) contains, inter alia, a provision to this effect. It stipulates that 22.5 per cent of governmental revenues derived from the small and artisanal operations in the form of taxes and royalties must be allocated to a special fund for reforestation and environmental rehabilitation of the affected areas. Under the new regularization programme effective in Ghana, licensed gold buyers pay the equivalent of 3 per cent of the value of the gold purchased into the Land Reclamation Fund installed by the Government.

46. Apart from health and safety regulations, modern labour and mining legislation usually includes provisions placing mine operators under the obligation to provide

a minimum standard of social services, primarily in terms of changing rooms with safe water, lighting, sanitation and first-aid facilities. At remote mine sites, additional services are frequently offered, including housing, staff stores, meals, transport, and recreational, educational and cultural facilities.

47. In general, availability of such requirements diminishes with decreasing mine size, being practically non-existent in artisanal mining. While the elementary services such as water, lighting and sanitation are usually made available at the organized small operations, additional facilities are the exception rather than the rule.

48. The implementation of a basic standard of social services necessary to prevent diseases should be enforced in all small-scale mining activities by the authorities responsible. Again, this will hardly be possible in the informal sector of artisanal mining unless legalized entities, such as formal small producer units or co-operatives, are created which can be addressed and controlled.

C. Regional beneficiation and purchasing centres

49. To obtain a marketable product and to eliminate the transportation of large quantities of sterile material, many minerals extracted by small-scale mining require some form of treatment and pre-processing. A decisive consideration is the concentration factor - the ratio of the quantity of run-of-mine processed ore to one unit of saleable commodity. As a general rule, the higher the concentration factor, the closer to the point of extraction the concentration process has to be conducted.

50. Concentration factors are comparatively low with coal and most non-metallic minerals, high with metal ores and extremely high with precious minerals. Gold ore, therefore, has to be processed right at the point of extraction, metal ores as close as possible to the mine site. To reduce the extent of beneficiation required, small miners have a tendency to pre-concentrate by selectively mining higher grade ore, a practice which in its extreme form is wasteful and, thus, undesirable.

51. The availability of beneficiation facilities in the vicinity of mine sites contributes to a reduction in such high-grading practices, thereby enhancing the quantity of mineable resources and the life of the mine. In view of the limited production of small operators, the installation of captive mills at individual mine sites is usually not justified. In metal mining districts the establishment of regional beneficiation plants serving several operators has, therefore, proved successful.

52. Given the limited mobility of small miners and the associated constraints in product marketing, the availability of ore collecting and purchasing centres is an equally important promotional condition encouraging small-scale metal mining activities.

53. Regional concentrators operated by a governmental institution have been in use in the small-scale mining segment of Mexico for more than 25 years treating ore of several hundred small mines. In Chile, Empresa Nacional de Mineria (ENAMI) operates four regional copper concentrators, treating ore purchased from numerous small and medium operators. The agency also maintains 16 mineral purchasing centres located throughout the country which serve the small miners as marketing outlets. The existence of the ore-buying stations has proved highly beneficial in stimulating small-scale mining in the country.

54. In Morocco, CADETAF, a governmental agency, offers similarly essential services to the artisanal miners extracting high-grade lead and zinc ore in the southern Atlas. It operates seven regional ore purchasing centres that also provide basic materials and essential services to the miners. Purchases are made based on average monthly prices quoted at the London Metal Exchange, adjusted to account for handling, transport and treatment charges and taxes. Several mobile concentrators have recently been introduced in the artisanal gold mining segment in Ethiopia in an attempt to replace the traditional panning method.

55. Apart from their promotional effect on small mining activities, regional beneficiation plants help to reduce the environmental problems caused by small-scale mining, as indicated above. Purchasing centres can serve the same objective if used by the authorities to collect a levy set aside for the reclamation of abandoned mine sites.

D. Co-operatives and private sector initiatives

56. While collective organizational arrangements in the form of co-operatives have an image of inefficient business conduct, due to adherence to the principle of democratic decision-making, indications are that they present a favourable option in all cases in which circumstances prevent the establishment of small private enterprises. This is, inter alia, documented by the successful performance of the chromite mining co-operatives in Zimbabwe, mentioned in chapter I.

57. The co-operatives established in Zimbabwe are business enterprises which operate on a self-help basis for the economic benefit of their members, who are, in effect, owner-employees pooling their resources. The number of members of the producing chromite co-operatives on the North Dyke ranges from 20 to 250. The average income of co-operative members in 1989 was $Z 120 per month, clearly above the minimum wage rate of $Z 75 per month.

58. In 1987, the producing chromite co-operatives together established the North Dyke Mining Co-operative Union to act as a collective service organization. Its main function is to supply operating inputs to producing co-operatives at cost, including explosives, carbide, timber, protective clothing and pump accessories. It also provides transport services and operates recreation centres.

59. The conditions required for the formation and registration of a mining co-operative in Zimbabwe are as follows:

(a) There must be a group of at least 10 persons willing to form a co-operative;

(b) The group must have mining rights to a mineral deposit samples of which must be assayed by the authorities to determine the potential;

(c) In case of favourable results, the mining location must be registered with the Mining Commissioner;

(d) The deposit will then be evaluated by a governmental geologist;

(e) If the evaluation is positive, the group can apply for registration as a mining co-operative.

60. Private initiatives in the form of artisanal microscale mining present the least desirable organizational choice of small-scale mining. They are usually highly inefficient and wasteful and lack safety, environmental responsibility and basic social requirements. Because of the large number of individuals and their irregular work practices, they are extremely difficult to control. Every effort should, therefore, be made to encourage the formation of suitable, larger organizational entities in artisanal mining districts, such as co-operatives, miners associations and formal small private enterprises.

61. Only larger organizational units can be efficiently addressed, assisted and controlled by the authorities and held responsible in case regulations are not adhered to. In addition, a minimum organizational size is a pre-condition for effective operation as well as for the negotiating power required in the procurement of operating inputs, product marketing and dealing with the public bureaucracy.

62. The most dynamic and generally the most appropriate type of organization in small-scale mining is the small private enterprise, comprising the owner/operator and a limited number of hired, paid labourers. It is the preferred organizational form in the small-scale mining segment of many industrialized countries. Small private firms are usually more competitive than co-operatives.

63. The establishment of private enterprises in small-scale mining in developing countries should, therefore, be encouraged wherever possible. The removal of major barriers to entry in terms of finance and skills requirements and the creation of the appropriate monetary incentives are key prerequisites.

E. Financing incentives

64. In spite of the comparatively modest capital requirements of small mines, securing the monetary resources necessary to finance fixed assets and working capital is a typical constraint encountered in small-scale mining. Due to severe limitations in providing an acceptable collateral, combined with the risk inherent in mining, debt financing through commercial banks is particularly difficult to obtain by the small operator. Equity financing, based on the limited personal

savings of the entrepreneur and possible associates has, therefore, been the traditional method of raising capital.

65. Again, Zimbabwe offers an illustrative example on useful ways to alleviate the financial constraints in small-scale mining. There, a plant-hire scheme administered by the Chief Mining Engineer and executed through regional mining engineers has been introduced by the Government, specifically set up to assist the small miner. Designed as a hire-to-purchase arrangement with terms between 12 and 36 months, equipment is made available to the small miner upon payment of a small deposit and hire charges set at capital cost plus 10 per cent annual interest.

66. In addition, various types of loans at favourable terms funded by the Government are offered to the miners, including emergency loans, loans to purchase mines, to develop mines and for the construction of the required operational infrastructure, such as electricity and water supply.

67. A similar scheme of credit facilities initiated to assist the small and medium mining segment exists in Chile. As part of its services, ENAMI provides short- and medium-term loans to small-mine operators and grants emergency advances and advance payments on ore purchases. The agency also provides repayment guarantees on credits for the purchase of essential mining equipment by small miners.

68. In Mexico, credit facilities for small and medium enterprises engaged in mining are made available through PECAM, a special complementary programme created by the Government with the support of multinational lending institutions. The programme provides credits to small mines to finance exploration activities, technical assistance work, fixed assets and working capital requirements. In the period from 1986 through 1989, the loan portfolio available for this purpose amounted to $US 210 million. Morocco and Bolivia also provide credit facilities to small enterpreneurs.

III. INTERNATIONAL AND REGIONAL POLICIES

A. Co-operation in marketing precious metals and stones

69. The marketing of precious minerals produced by the artisanal microscale mining segment is a particularly delicate matter in many developing countries due to the frequently observed tendency to trade the minerals illicitly. In view of the resultant losses in governmental revenue, establishing a functioning legal mechanism of marketing outlets is a high priority objective in most countries concerned.

70. Empirical evidence confirms that guaranteed payment of a fair price for the product in real terms is a pre-condition to making the mechanism work. In an economic environment with an overvalued currency, this will necessitate payment of an adequate premium on commodity prices based on the official exchange rate. A number of developing countries with a significant artisanal-scale precious minerals production, including Colombia and Ghana, have successfully experimented with this instrument. Another way to create the necessary confidence in the pricing system

among small producers, especially with gemstones, can be to market by public auctioning.

71. While information on international co-operation in this field is scarce, the approach followed by Zimbabwe presents an interesting option. Apart from the relevant activities of the parastatal Zimbabwe Mineral Marketing Corporation, all branches of Barclays Bank in the country have been authorized to purchase gold on sight, making immediate payment to registered and regular producers. In view of the success of this system at the national level, commercial banks with an extensive network of branch offices across national borders could be considered for gold marketing on a regional scale.

72. Implementation of a regional gemstone buying, processing and marketing project is currently being examined by the Southern African Development Co-ordination Conference (SADCC). The region is a significant producer of industrial and gem-quality diamonds as well as precious and semi-precious stones such as emeralds, tanzanites, rubies and aquamarines. The objective of the project is to develop a regional strategy for buying, cutting, polishing and selling gemstones, to eliminate illegal mining and illicit trading, and to enhance employment generation, training and foreign exchange earnings by the industry.

B. Pooling of technical assistance

73. With unsafe and inefficient mining methods and work practices a common characteristic of small-scale mines in developing countries, the continued provision of extensive technical assistance designed to improve working conditions must be made an essential element of sector-specific promotional programmes. The pooling of technical assistance on a regional scale, therefore, can provide a means of accelerating the process and enhancing its efficiency.

74. Existing regional organizations, including ESCAP, ASEAN, the Andean Pact and SADCC, can serve as co-ordinating centres in the implementation of this strategy. It will contribute to avoiding duplication of effort and will benefit from the experience and knowledge generated by technical assistance in other small-scale mining communities of the region. The pooling of technical assistance offered by co-operating partners in the interest of regional development is one of the functions of the Mining Sector Co-ordinating Unit established by SADCC.

C. Transfer of technology

75. Small mines, frequently operating under confined and narrow spatial conditions, are generally not well suited for the application of highly mechanized, capital-intensive mining methods using sophisticated machinery. In an economic environment with a scarcity of capital and an abundance of cheap labour - a situation prevalent in many developing countries - the least costly method of production is one with a low-to-intermediate degree of mechanization, based predominantly on local inputs.

76. As a consequence, the modern mining techniques used almost exclusively in the mining industries of industrialized nations today are frequently not appropriate for small mines in developing countries. A possible exception is open-pit mining, producing low-value bulk minerals. On the other hand, intermediate technologies that would be appropriate in most cases were largely replaced in the industrialized nations many years ago, and the relevant expertise has disappeared.

77. From this it follows that the transfer of technology to small-scale mining activities has to take place primarily among developing countries. Developing countries with a long tradition in mining and a well developed small-scale mining segment, including Bolivia, Brazil, Chile, China, India, Mexico and Zimbabwe, can play an important role in this process. Internationally active agencies, specialized in this field, such as the Intermediate Technology Development Group, based in London, and Appropriate Technology International, based in Washington, D.C., can be equally helpful.

D. Contribution of international agencies

78. International organizations, including the World Bank, other multinational lending institutions and various United Nations agencies have made significant contributions to the promotion of small-scale mining activities in a number of developing countries in the recent past. United Nations agencies have helped to promote the activity directly or indirectly in Benin, Burkina Faso, Chad, Chile, Colombia, Ethiopia, Ghana, Guinea, Guyana, Indonesia, Kenya, Malaysia, Mali, Nepal, Pakistan and Rwanda, among others.

79. The World Bank has recently conducted reviews of the mining sector in the Sahel countries, in Guinea, Rwanda and the United Republic of Tanzania, with special emphasis on the small-scale mining prospects of precious minerals or high-value metals such as tin. It is currently supporting Bolivia in the rehabilitation of the mining sector, including technical assistance provided to the small-scale segment in the preparation of suitable projects. An additional project aimed at strengthening the institutional framework in Ecuador is under preparation, addressing measures to regulate small-scale gold mining, among other issues.

80. While traditional forms of financial and technical assistance provided by international agencies are continuing, initiatives increasingly focus on environmental, health and social aspects. In addition, particular attention is being given to the creation of an economic environment conducive to small-scale mining. Recognition of the vital role of an enabling environment in encouraging productive activities in general is the motive for the new emphasis. Principal elements include an attractive mining code, a tax régime providing adequate incentives, a supporting institutional framework, the basic physical infrastructure and durable political stability.

81. In the SADCC region, a study is currently being undertaken aimed at reviewing and analysing the regulatory framework and the investment climate specifically related to mining development in each of the member States. The study, which is being carried out with support from the World Bank, covers nine sub-Saharan

countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, the United Republic of Tanzania, Zambia and Zimbabwe, plus Namibia as a new member State. Its objective is to make specific recommendations on action required to improve the economic framework for growth in the mining sector.

82. Small-scale mining is one of the priority areas of the work of the SADCC Mining Sector Co-ordinating Unit, operative since 1985 in Lusaka, Zambia. The staff of the unit, which receives extensive financial and technical assistance from the United Nations and the World Bank on a bilateral basis, includes one expatriate expert and one counterpart expert in small-scale mining. It is planned that, based on the regional project "Small-scale mining and minerals beneficiation" currently being executed, a number of national small-scale mining sub-projects will be developed and prepared for implementation.

IV. HUMAN RESOURCES DEVELOPMENT, TRAINING, AND TECHNICAL CO-OPERATION

A. Training and technical assistance

83. In its traditional form, mining is a physically demanding and complex business requiring a unique combination of special skills for different tasks, from the identification of valuable mineralizations through their safe extraction, efficient processing and profitable marketing to the associated general administrative and managerial functions. Therefore, in most types of small-scale mining, healthy and skilled workers are a key factor for a successful operation.

84. The level of skills required, however, varies considerably with the type and size of the operation and the commodity mined. For underground coal and metal mining involving extensive ground control and mineral beneficiation, trained mine workers are an absolute necessity. Extracting placer deposits in small surface operations or mining construction minerals in shallow open pits, by contrast, is substantially less demanding.

85. In any given case, training requirements to a large measure depend on the existence or absence of a mining tradition. Implementing a small-scale underground metal mining project in a developing country with little mining tradition will necessitate extensive pre-operational training programmes, while starting a quarry extracting industrial minerals in a country in which a construction industry has existed for many years will be possible with very little additional training.

86. The technical assistance necessary to train prospective and active small-scale miners will increasingly have to be provided by developing countries for developing countries in order to ensure the use of the appropriate technology, as discussed above. Training programmes for underground miners have to focus on the main elements of the trade, such as drilling and blasting, the handling of explosives, roof control, timbering, pipe and track laying, as well as the operation and repair of simple mine equipment.

87. Shift bosses and supervisors, moreover, will have to acquire a basic knowledge of mine surveying, preparing mine layouts based on established principles of mine

planning, placing and driving development workings, stopping methods and the implementation of mine safety regulations. Small mine managers and owners will have to receive training in book-keeping, accounting principles, stock control, commercial business transactions and report-writing.

88. Apprenticeship programmes conducted in existing well run small or medium mines, comprising extensive on-the-job training of the candidates under the guidance of experienced certified miners, are considered the preferable method. In the absence of suitable operations, the establishment of a demonstration mine for combined training and production purposes under the supervision of a governmental or regional agency would be a useful option. The SADCC Mining Sector Co-ordinating Unit is considering the construction of a demonstration mine in Zambia to serve the small-scale mining segment of the region.

B. Technical co-operation projects

89. A Government executed small-scale mining project specifically designed for human resources development has recently been funded by the United Nations Development Programme (UNDP) in Chile. The objectives of the project, which focuses on two pilot areas with polymetallic mineralizations of copper, lead, zinc, gold and silver, is to provide small operators with the technical and economic knowledge required from exploration through the financial appraisal of a mineral deposit. The ability to assess and prove the potential of a mineralization is essential in utilizing existing credit lines available for small miners.

90. In an ongoing programme, the United Nations helps the Department of Mines of Burkina Faso to promote the introduction of more efficient mining and processing methods to small-scale miners. As part of the programme, use of modern heap-leaching technology will be introduced, replacing traditional gravity processing in order to increase gold recovery.

91. In SADCC, a comprehensive regional survey of the skilled manpower requirements of the mining sector has been conducted with the support of the Commission of the European Economic Communities (EEC). As a follow-up project, an international expert on labour development is being attached to the Mining Sector Co-ordinating Unit to implement a mining labour development programme on a regional scale. It is expected that the small-scale mining segment will benefit from the programme in accordance with its share in the region.

V. RESULTS OF THE FIFTH TRIPARTITE TECHNICAL MEETING FOR MINES OTHER THAN COAL MINES

92. The Fifth Tripartite Technical Meeting for Mines other than Coal Mines, convened by the International Labour Organisation in Geneva from 28 March to 5 April 1990, confirmed the importance of small-scale mining as a significant segment of the extractive industry. The general report prepared for the meeting examined the constraints on and the economic significance of the industry, discussed the role of Governments and the private sector, and addressed safety, health, environmental and training issues.

93. The meeting stressed the contribution of small-scale mining to the creation of employment, frequently in remote rural areas, where alternative job opportunities are scarce. While reliable statistical data could not be presented, it was indicated that in countries with an active small-scale mining segment, labour engaged in the activity can amount to 50 per cent of total mining sector employment. Estimates of small-scale mining labour for selected developing countries are presented below. Most of this labour is engaged in the artisanal mining of precious minerals, notably gold.

Country	Labourers
Indonesia	365 000
Malaysia	23 000
Peru	20 000
Philippines	200 000
Zambia	15 000
Zaire	150 000 a/

a/ This figure may be conservative. It may be closer to 500,000 if diamond miners are recorded as well.

94. Conditions of purchase of mine output are considered an essential component of the promotion of small-scale mining. It has been observed that a difference between commodity prices paid by the Government and those prevailing on the world market in excess of 5 per cent will lead to illicit trading. The Government, moreover, has an important role to play in providing an appropriate regulatory framework which generates stability in the subsector and in ensuring that adequate safety and health standards are introduced and maintained.

95. Apart from inadequate equipment, the lack of mechanical skills and of fundamental geological, mining and processing know-how have been identified as major inhibiting factors in the successful economic development of small-scale mining. It is considered an important task of Governments to provide small-scale miners with basic geological information for successful prospecting and to establish an adequate training infrastructure for technical training related to the assessment of ore grades, sound mining practices and ore processing methods aimed at improving operational efficiency. Management training is a vital component of the training package.

96. Private-sector initiatives to establish small mining operations should be encouraged by the national authorities through incentives or by removing constraints and barriers to entry for entrepreneurs. The fact that the economy can benefit directly and indirectly in various ways from small-scale mineral development justifies governmental support in this process. Small mines contribute to employment, basic skill formation and infrastructure development and to public revenue in the form of taxes and royalties.

97. The Meeting placed special emphasis on issues related to both the natural and the working environment of small-scale mining activities. It noted that a significant difference exists between the safety performance of large and small-scale mines. Unhealthy working conditions and unsafe mining practices, frequently observed in small mines, are made possible where government safety and health regulations are inadequate or inspection is lacking.

98. Due to the absence of reliable and comprehensive reporting systems covering small-scale mining, the full extent of the number of accidents and the incidence of diseases in this activity is hardly known in many developing countries. Potential health hazards include physical and chemical factors such as dust, vibration, noise, heat, radiation, mercury, heavy work loads, the effects of chemical agents and mental stress resulting from shift work and the lack of social security.

99. Evidence exists that the working environment is particularly harmful in the artisanal segment of the small-scale mining sector, notably in gold and diamond mining. For example, manual labour is sometimes employed in underground gold mines for the vertical transport of ore in heavy sacks on rudimentary ladders; thousands of cases of malaria occur among the gold prospectors in the Serra Pelada region of Brazil; and the working conditions in the Kasai region of Zaire where diamonds are mined by individual creuseurs are also harmful.

100. The uncontrolled and inadequate use of mercury and cyanide for the recovery of gold from gold-bearing ore can have severe damaging effects on the health of the miners, the local population and the natural environment in which they operate and live. With more than 50 per cent of these chemical agents typically being lost in artisanal operations, the contamination of the local environment is substantial and in some cases irreversible.

101. Against this background, the Meeting emphasized the necessity of governmental initiatives to protect the natural and the working environment in small-scale mining in developing countries. In some cases strengthening the authorities responsible for the enforcement of relevant regulations will be required if unacceptable working conditions and environmental practices are to be eliminated. The legalization of small-scale mining operations along with the provision of technical and management assistance is considered equally important in order to enable Governments to implement and control basic health, safety and environmental standards.

VI. CONCLUSIONS

102. Interest in small-scale mining continues to be strong in many developing countries, as demonstrated by the high level of activities in the subsector. The relatively good performance of the small-scale chromite mining co-operatives in Zimbabwe and the regularization process of the artisanal gold mining activities in Ghana document the importance of issue-oriented governmental initiatives and their positive effect on subsector development.

103. Small-scale mining has been identified as an economic activity providing significant employment opportunities, utilizing numerous small, otherwise

unexploitable mineralizations with moderate requirements in terms of lead time, capital and skilled labour, and substantial linkage effects - a combination of attributes providing ample justification for continued promotion of the subsector. Frequently observed undesirable practices, including environmentally damaging behaviour, safety hazards, social neglect and illegal trading, necessitate intervention by the authorities. The elimination of negative effects and the maximization of benefits require an appropriate set of policies.

104. On the national level, a policy element designed to encourage the establishment of accountable organizational structures, such as co-operatives, small miners' associations or small private firms, will be necessary in order to eliminate environmentally and socially unacceptable practices, notably in the informal, artisanal microscale mining districts. Accumulation of funds for land rehabilitation collected from producers is an important complementary measure. Availability of regional beneficiation facilities and purchasing centres has a strong promotional effect in small-scale metal mining districts. While co-operatives are suitable organizations, small private enterprises are preferable in view of their usually more dynamic and competitive performance. Plant-hire schemes and special loan arrangements have proved highly encouraging for small-scale mining activities, and should, therefore, be made available wherever justified by the extent of small-scale mining activities.

105. Regional marketing of precious minerals through commercial banks offers a simple option requiring little investment where an adequate network of branch offices exists. The pooling of technical assistance, utilizing existing regional organizations as co-ordinating mechanisms, is a promising strategy which can accelerate the promotional effect and enhance its efficiency. To ensure the use of appropriate technologies in small-scale mining, a transfer of technology will increasingly have to take place between developing countries. Human resource development is a key issue in small-scale mining. Extensive technical assistance in the form of specifically designed training programmes, implemented in suitable producing operations or special demonstration mines, is required in all types of small-scale mining.

106. The conclusions presented here are offered as a basis for discussion so as to enable the Committee to delineate priority areas for future action related to small-scale mining. In view of the continuing importance of small-scale mining in many developing countries, the Committee may wish to keep under review the experience gained through technical co-operation activities and monitor the progress achieved by countries in this sector.

Notes

1/ United Nations publication, Sales No. E.72.II.A.4.

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